January 19, 1959

Aviation Week

Including Space Technology

75 Cents

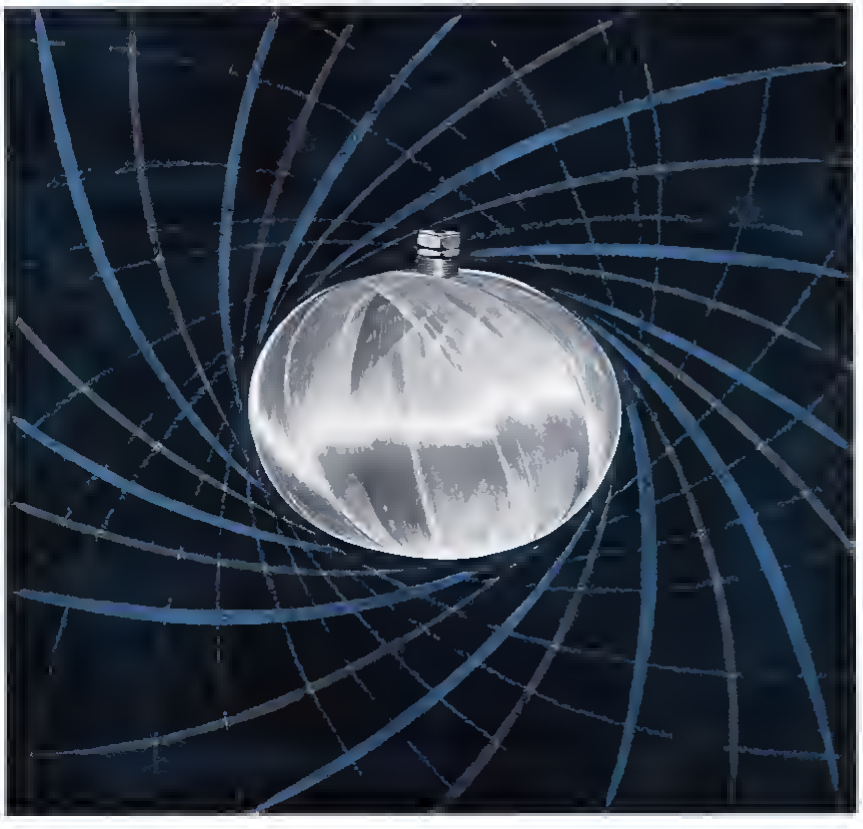
A McGraw-Hill Publication

Minuteman Site Poses Challenge

•

Lunar Probe Trajectories

Convair Atlas 9-B Launching



HOW HIGH THE PSI? (BRUNSWICK "BOTTLES" UP TO 200,000)

Here's the big news in the pressure vessel field: Brunswick's new, unique Strickland "B" Process (SBP) now results in filament wound plastic vessels with the greatest strengths ever obtained. At the same time, vessel weights have been drastically pared down. Brunswick can create vessels (from that shown above to air bottles and rocket motor cases) with these specifications:

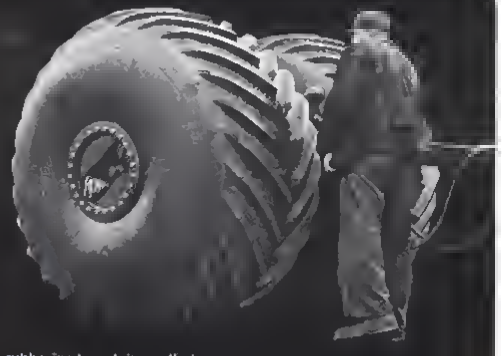
Hoop stress values in the range of 175,000 to 200,000 psi. Burst strength values up to 150,000 psi. Weight: 20 to 40 per cent *less* than that of *any* previously built plastic vessels. Temperature limits: up to 600° F. Super tough SBP vessels are also ideal for components that must stand up to extended operating cycles, and can be mass produced in compound and monocoque shapes.

For proposed or existing projects involving pressure vessels, Brunswick offers skillful assistance in the design, development and fabrication stages. For more details concerning the higher strength–lower weight advantages of SBP components, write or call The Brunswick-Balke-Collender Company, Defense Products Division Sales Manager, 1700 Messler St., Muskegon, Michigan.

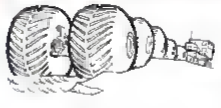
BRUNSWICK

MAKES YOUR IDEAS *WORK*

Does your weapon system need fuel "on the double"?

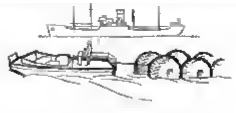


Here—from Goodyear—are ingenious new rubberized containers that offer double dividends: lightweight liquid storage plus unmatched all-weather mobility.



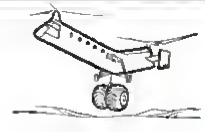
NEED FUEL THAT ROLLS WITH YOU?

These big Rolli Tankers hold 500 gallons each, can be towed in long "fuel trains" over roughest terrain. Tire-like containers roll so easily a man can pull one.



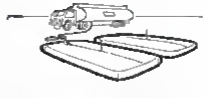
—OR FLOATS WITH YOU?

Filled with fuel, Rolli Tankers have natural buoyancy—ride through water, roll right up the beach! Eliminates long-line hoses and pumping.



—OR COMES BY AIR?

Delivered by air, Rolli Tankers can be attached to waiting trucks *—and rolling—*in matter of minutes. Fully loaded tankers survive free falls of 15 feet.



HOW ABOUT A PORTABLE FUEL FARM?

Called "Pillow Tanks," these tough, rubberized fabric containers can be set up filled and pumping in 45 minutes. Great where temporary or emergency storage of bulk liquids is needed.

LOOK! FLOATING FUEL STATION

"Pillow Tanks" *in the water* serve as "fuel islands"—eliminate stringing of long-line hoses or pumping from remote points. Tanks available in sizes up to 50,000 gallons.

WANT TO SAVE FUEL SPACE?

Goodyear has pioneered the development of spacesaving fuel cells and tanks for aircraft, boats, vehicles, missiles. This experience can best answer *your* fuel storage problem.

FOR COMPLETE INFORMATION on these and other new developments in fuel storage and transport, write Goodyear Aviation Products Division, Akron 16, Ohio or Los Angeles 54, California.

AVIATION PRODUCTS BY

GOODYEAR

AVIATION CALENDAR

Jan. 23—Western Regional Meeting, Institute of Navigation, March AFB, Riverside, Calif.

Jan. 26-27—Annual Meeting, Assn. of Local and Territorial Airlines, National Aviation Club, Washington, D. C.

Jan. 26-29—27th Annual Meeting, Institute of the Aeronautical Sciences, Sheraton-Astor Hotel, New York, N. Y. Honors Night Dinner, Jan. 27.

Jan. 26-29—39th Annual Meeting, American Meteorological Society, Barbizon Plaza Hotel, New York, N. Y.

Jan. 27-30—15th Annual Technical Conference, Society of Plastics Engineers, Hotel Commodore, New York, N. Y.

Jan. 28-29—Fifth Annual Midwest Welding Conference, sponsored by Armour Research Foundation, Illinois Institute of Technology, Chicago, Ill.

Jan. 30-Feb. 1—Miami International Air Show and Exposition, Masters Field, Miami, Fla.

Feb. 3-5—14th Annual Technical and Management Conference, Reinforced Plastics Division, Society of the Plastics Industry, Inc., Edgewater Beach Hotel, Chicago.

Feb. 12-13—1959 Solid State Circuits Conference, sponsored by Institute of Radio Engineers' Professional Group on Circuit Theory, American Institute of Electrical Engineers' Committee on Electronics and University of Pennsylvania, Philadelphia.

Feb. 12-13—Computer and Data Processing in Industry conference for manufacturing and engineering management, Purdue University, Lafayette, Ind.

Feb. 14—Meeting on Short Range Navigational Aids, International Civil Aviation Organization, International Aviation Bldg., Montreal, Canada.

Feb. 21-22—13th Annual Pacific Coast Mid-Winter Soaring Championships, Torrey Pines Gliderport, San Diego, Calif.

(Continued on page 6)

AVIATION WEEK including Space Technology

January 19, 1959

Vol. 70, No. 3

Published weekly with an additional issue in December by McGraw-Hill Publishing Company. James H. McGraw (1860-1948), Founder. See panel below for directions regarding subscriptions or changes of address. Executive, Editorial, Circulation and Advertising Offices, McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y. Publication Office, 99-129 North Broadway, Albany 1, N. Y. Donald C. McGraw, President; Joseph A. Gerardi, Executive Vice President; J. Keith Gambrill, Vice President and Treasurer; John J. Cooke, Secretary. Officers of the Publications Division: Nelson L. Bond, President; Harry L. Waddell, Senior Vice President; Ralph B. Smith, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator.

Subscriptions are solicited only from persons who have a commercial or professional interest in aviation including missiles and space technology. Position and company connection must be indicated on subscription order.

Single copies 75¢. Subscription rates—United States and possessions, $7 one year. Canada, $8 one year. All other countries, $50 one year.

Second class postage paid at Albany 1, N. Y. Printed in U. S. A. Title registered in U. S. Patent Office.

©Copyright 1959 by McGraw-Hill Publishing Co., Inc. All rights reserved. Cable Address: McGraw Hill New York. Publication combined with AVIATION WEEK'S including SPACE TECHNOLOGY are AVIATION NEWS, AIR TRANSPORT, AERONAUTICAL ENGINEERING and AIRCRAFT JOURNAL. All rights to these names are reserved by McGraw-Hill Publishing Co.

Subscribers: Send correspondence and change of address to Fulfillment Manager, Aviation Week, 330 West 42nd Street, New York 36, N. Y. Subscribers should notify Fulfillment Manager promptly of any change of address, giving old as well as new address—including postal zone number. Enclose recent address label if possible. Allow one month for change to become effective.

Postmaster: Please send form 3579 to Aviation Week, including Space Technology, 330 West 42nd Street, New York 36, N. Y.

AVIATION CALENDAR

(Continued from page 5)

Feb. 23-26—Third Annual Symposium on Thermal Properties. Purdue University, Lafayette, Ind. Sponsor: Heat Transfer Division of American Society of Mechanical Engineers.

Feb. 26-March 1—1959 Engineering Exposition, Balboa Park, San Diego, Calif. Address inquiries to: 422 Land Title Bldg., San Diego, Calif.

March 3-5—1959 Western Joint Computer Conference, sponsored by Institute of Radio Engineers, American Institute of Electrical Engineers and Assn. for Computing Machinery. Fairmont Hotel, San Francisco, Calif.

March 5-6—Flight Propulsion Meeting (classified). Institute of the Aeronautical Sciences. Hotel Carter, Cleveland, Ohio.

March 5-7—Western Space Age Conference and Exhibit. For information: Domestic Trade Dept., Los Angeles Chamber of Commerce, 404 South Bixel St., Los Angeles 54, Calif.

March 8-11—Gas Turbine Power Conference and Exhibit. Netherlands-Hilton Hotel, Cincinnati, Ohio. Sponsor: American Society of Mechanical Engineers.

March 9-12—Aviation Division Conference, American Society of Mechanical Engineers, Statler-Hilton Hotel, Los Angeles, Calif.

March 10-11—Third Annual Shock Tube Symposium. Old Point Comfort, Ft. Monroe, Va. For details: Armed Forces Special Weapons Center, Kirtland AFB, Albuquerque, N. M. Attn: SWRS-R-R, Birnkoff.

March 16-20—11th Western Metal Exposition and Congress. American Society for Metals, Pan Pacific Auditorium and Ambassador Hotel, Los Angeles, Calif.

March 23-26—National Convention, Institute of Radio Engineers, Coliseum and Waldorf-Astoria Hotel, New York, N. Y.

March 31-Apr. 2—Polytechnic Institute of Brooklyn's Ninth International Symposium. Subject: Millimeter Waves. Auditorium, Engineering Societies Bldg., New York, N. Y. Cosponsors: Department of Defense Research Agencies and Institute of Radio Engineers.

March 31-Apr. 3—National Aeronautic Meeting, Society of Automotive Engineers, Hotel Commodore, New York, N. Y.

Apr. 2-3—Conference on Electrically Exploded Wires, sponsored by the Thermal Radiation Laboratory of the Geophysics Research Directorate of the Air Force Cambridge Research Center, Somerset Hotel, Boston, Mass.

Apr. 5-10—1959 Nuclear Congress. Municipal Auditorium, Cleveland, Ohio. For information: Engineers Joint Council, 29 West 39th St., New York 18, N. Y.

Apr. 7-10—1959 Welding Show and 40th Annual Convention, American Welding Society, International Amphitheatre and Hotel Sherman, Chicago, Ill.

Apr. 12-19—Air Force Assn.'s World Congress of Flight, Las Vegas, Nev.

Apr. 18-22—Annual Meeting, American Society of Tool Engineers, Schroeder Hotel, Milwaukee, Wis.

Apr. 22-24—1959 Annual Meeting, Institute of Environmental Engineers, LaSalle Hotel, Chicago, Ill.

2 gyro all-attitude master reference

ACCURACY:

D G free drift 1 deg./hr.
¼ deg. bench verticality
in-flight verticality with GPC
(Geocentric Pendulum Control) 1 deg.

Available Now! The LEAR 2171 all-attitude two-gyro master platform is now in production—assuring early delivery schedule for all applications requiring highly accurate vertical and directional gyro signals.

Proven in 3,000 hours of bench time—over 2,000 hours of flight time—in eight types of fighter and bomber jet aircraft.

Specified for operational use in high-performance fighter aircraft—(USAF) Republic F-105 and Convair F-106; (Navy) Douglas A4D-2 and McDonnell F4H.

CAPABILITIES

ALL ATTITUDE REFERENCE FOR

Indicators	AFC
Compasses	Fire Control
Dopplers	Toss Bombing
Radars	LABS

FEATURES

- Electrolytic Erection
- GVR (Geocentric Vertical Reference) Capability
- Oscillating D G Gimbal Bearings
- All attitude (4 Gimbal)
- Photo Electric Pick Off
- Dual Synchro Output on Each Axis
- High Response, Roll Rate of 360 deg./sec. and pitch rate of 200 deg./sec
- Production Proven Components

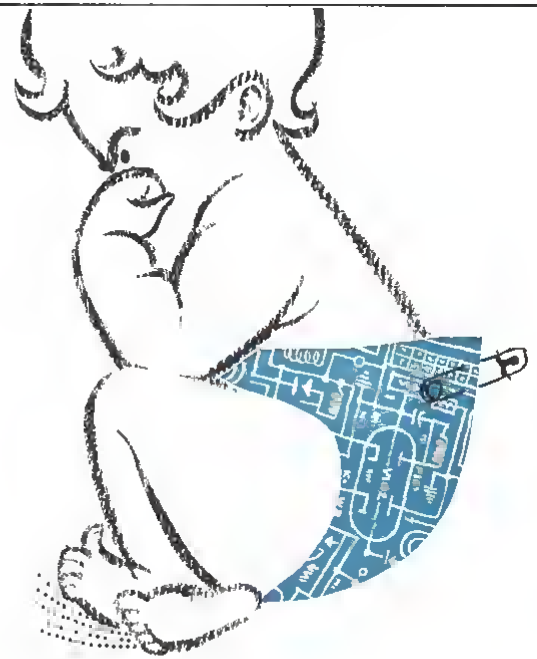
LEAR

GRAND RAPIDS DIVISION
...ONIA AVE., N.W., GRAND RAPIDS 2, MICHIGAN

GYROSCOPES ■ AC/DC MOTORS ■ ACTUATORS ■ SERVOS ■ MAGNETIC CLUTCHES ■ POSITIONING CONTROLS

GR 461

Our specialty at Simmonds is the problem type of engineering project, rather than the routine. Precision and high performance are inherent in all our products . . . sensitive electronic fuel management systems, fuel injection systems, electronic instruments and precision mechanical equipment. Our engineers are experienced in forward-looking design to meet the more exacting requirements of today and tomorrow. The size of our organization permits flexibility and speed in the application of new ideas. We are well known also for rendering exceptional service to our customers.



The "Problemchild" is Our Baby!

SIMMONDS

GENERAL OFFICES, TARRYTOWN, NEW YORK • BRANCH OFFICES GLENDALE, CALIFORNIA • SAN DIEGO CALIFORNIA • WASHINGTON D C • DAYTON OHIO
ST LOUIS MISSOURI • DALLAS, TEXAS • DETROIT, MICHIGAN • SOLE CANADIAN LICENSEE, SIMMONDS AEROCESSORIES OF CANADA LIMITED, HAMILTON, ONTARIO

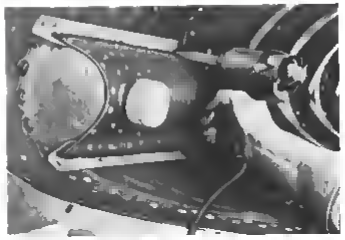
HOW TO SOLVE AIRCRAFT AND MISSILE DESIGN PROBLEMS WITH

SILICONE IDEAS

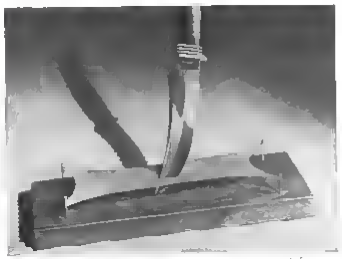
New silicone rubber cures without heat, keeps physical and electrical properties to 600°F

Need to seal or caulk metal, glass or plastic parts? Encapsulate or pot delicate assemblies? Mold silicone rubber parts in place? Patch or repair rubber parts? Need a flexible, heat resistant, accurate self-releasing mold for low-cost plastic tooling or model making?

New G-E RTV silicone rubber will do all this and more. Cures at room temperature in any time you select up to 48 hours. Stable up to 600°F. Excellent electrical properties. Tough, elastic, bonds well to primed surfaces. Has good resistance to aircraft fluids and fuels. Viscosities from very pourable to spreadable. Solvent free—shrinks less than 0.2% while curing. Write for technical data. Samples available for evaluation—just give us a brief description of your application.



RTV sealing in Douglas DC-8 jet nac



New silicone rubber shows 800% elongation, 225 lb/in tear strength, 1750 psi tensile strength

New high strength silicone rubbers meet new, tougher specifications

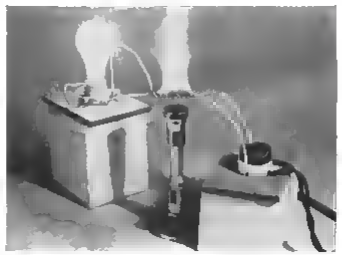
Last year G.E. doubled the strength of silicone rubber to make possible silicone parts with physical properties comparable to those of organic rubber. Since that time other improved and high strength G.E. compounds have filled out the line. Now the requirements of almost any rubber application can be met without having to compromise between the temperature resistance of silicones and the physical strength of organics.

A number of new government and industry specifications have been written to take advantage of these developments. These specs, of course, are the best way for you to call for the properties you need and still give your rubber fabricator flexibility to use the newest available compounds. Write for a list of the latest specifications and data on new higher strength silicone rubber.

Better performance at 1/5 the cost ... with new silicone rubber insulated wire

New thin wall constructions of silicone rubber insulated wire are replacing more expensive high temperature wire in many applications. Silicone rubber can withstand current overloads of 300 to 400%. The same test causes a higher priced insulation to decompose and fail.

Under emergency conditions silicone rubber gives maximum protection because it does not melt at high temperatures or give off toxic fumes—(when burned in a direct flame it forms a non-conducting ash which continues to insulate). It has outstanding resistance to temperature extremes, ozone, corona, radiation and cold flow. Excellent electrical properties are retained at elevated temperatures. Installation is easier because silicone rubber is truly flexible and strips easily. Write for complete technical data.



Silicone rubber insulated wire conducts even in an 1800°F flame

Send for more information

GENERAL ELECTRIC

Silicone Products Department, Waterford, New York

Section D831, Silicone Products Dept
General Electric Company, Waterford, New York

Please send me further data on

☐ Silicone Rubber Wire Insulation ☐ High Strength Rubber ☐ RTV Rubber

Name _____ Title _____

Company _____

Address _____

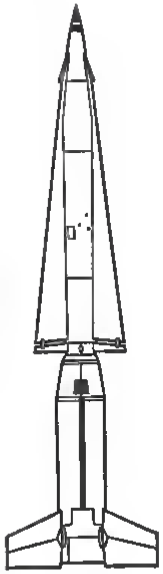
City _____ Zone _____ State _____

The man:

A U.S. Army missileman working with Nike Hercules missile equipment. The modern Army relies heavily on the special skills and knowledge of men like this who are trained extensively in military schools, and supported technically in the field by Army Ordnance Corps, Western Electric and Douglas field service men.

The mission:

Defense of U.S. cities. Army Nike Hercules units are already on duty at many key points... have the important assignment of guarding against enemy aircraft.



The missile:

Douglas-built Nike Hercules, product of a Douglas-Western Electric-Army Ordnance team, has successfully engaged supersonic drone targets at altitudes well over 60,000 feet. Other drone targets have been destroyed up to 100,000 feet, and at ranges beyond 75 miles.

Status . . . . . Combat ready
Range . . . . . 75 miles plus
Speed . . . . . Supersonic
Warhead . . Nuclear or conventional
Service . . . . . U.S. Army

Depend on DOUGLAS

The Nation's Partner in Defense

ZIPPERTUBING NEW PRODUCTS

SHIELDED ELECTRONIC CABLES IN ONE STEP

Multi-conductor electronic cable or harnesses which require RF, UHF, magnetic or radiation shielding can be quickly made up with the revolutionary, new shielded ZIPPERTUBING. Lamination of pure metal foil to the inner surface of ZIPPERTUBING jacketing provides shielded cable at a fraction of the cost of conventional tinned copper wire shielding plus outer jacketing. This new process also permits 100% effective shielding of main cable and branchouts without tedious hand wrapping, thereby saving up to 90% in labor cost.

RF and UHF Shielded ZIPPERTUBING consists of a vinyl saturated fiberglas jacket laminated to pure aluminum or copper foil. RF shielded jacketing is flame resistant and has a temperature range of -40°F. to 392°F.

A typical multi-conductor cable with a shielded ZIPPERTUBING jacketing. The pencil shows the laminated metal foil

Magnetic shielded ZIPPERTUBING consists of Conetic steel laminated between layers of vinyl, Mylar* or fiberglas. Additional laminations may be specified for increased protection. With each additional layer, the amount of magnetic shielding is squared.

Radiation shielded jacketing is made of vinyl covered lead saturated glass cloth. It may be used for constructing new cables or as an outer protective jacketing over existing cables that may be replaced when contaminated.

The ZIPPERTUBING shielded cables are particularly easy to ground through a wide variety of methods. One of the most popular consists of a 1/10" copper tinned braid which is machine sewn to the inner flap of any shielded jacketing at the factory. This process permits the user to effectively ground the cable at any desired point.

ZIPPERTUBING shielded jackets are available in 3/4" I.D. and up, in 1/8" increments and are provided in a wide selection of colors. Complete technical information is available upon request.

FREE CABLE CALIPER

Zippertubing cable caliper has been specially developed for showing the actual diameter of any multi conductor electronic cable at a glance. It also indicates the proper size of Zippertubing for a tight-fitting cable jacket. The Zippertubing caliper is handy for measuring any cylindrical object up to 2" in diameter. It will be furnished free on request.

**Trademark of duPont.*

Type ALAS Thermazip

THERMAZIP Resists Missile Firing

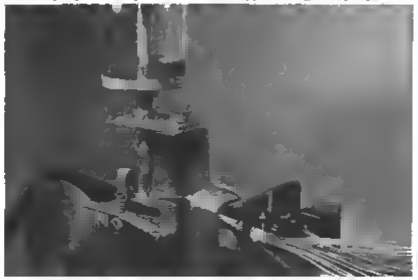
Zippertubing THERMAZIP, known as type ALAS, will withstand operating temperatures of 2000°F. This was proved in recent firings of major ICBMs where THERMAZIP was used to protect electronic cables exposed to the direct launching blast of the missile. This revolutionary jacketing has survived two launchings and has completely protected the cables it enclosed.

THERMAZIP is made of aluminized reflective asbestos fiber which quickly zips around the cable. A double external flap protects the point of closure. Other materials available include aluminized silicon rubber-coated glass cloth with great corrosion resistance for protection from -100°F. to 500°F. Plain asbestos THERMAZIP is also available.

AUTOMATIC CABLE MACHINE SUCCESSFUL

Since its recent announcement, the new Zippertubing automatic cablemaking machine has been successfully used by many manufacturers for making their own multi-conductor electronic cables. The revolutionary machine automatically makes cables with up to 108 conductors and applies either shielded or regular jacketing in a one-step operation. Labor costs, capital equipment expenditures and production lead time are drastically reduced.

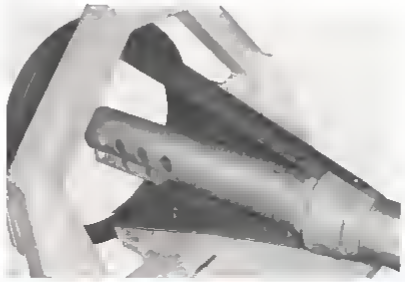
The inexpensive machine is available on lease, lease-purchase or outright purchase plans from The Zippertubing Company.



Close up of cable machine head showing cable being formed and sealed

For complete catalog information or field engineering service, write to

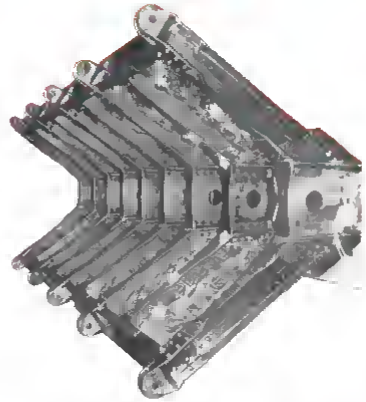
The Zippertubing Co., 752 So. San Pedro St., Los Angeles 14, Calif.
TWX LA 340. Sales offices and warehouses in all principal cities.



NOSE CONE SPLICE JOINTS ARE FASTENED WITH HS67 RINS TYPE 431 STAINLESS STEEL HEAT TREATED TO 125,000 PSI MINIMUM SHEAR. THE HS60M COLLARS ARE R MONEL

WING SPARS, FRONT AND REAR, HAVE SPAR CAPS ATTACHED TO WEB SECTIONS WITH HSF2 PINS. A286 ALLOY, HEAT TREATED TO 95,000 PSI MINIMUM SHEAR. HS60M COLLARS ARE USED.

...STHUR FASTENERS
...MANUFACTURED AS
...HI-SHEAR INCLUDE
...HI-TORQUE BOLTS
...BLIND BOLTS
...HI-NUTS AND
...HI-LOK FASTENERS



WING ATTACH STRUCTURE IS ASSEMBLED WITH INTERFERENCE FIT HI-SHEAR RIVETS. THE HS128 PINS ARE 37.4PH STAINLESS STEEL HEAT TREATED TO 120,000 PSI MINIMUM SHEAR. THE HS91 AND HS92 PINS ARE A 286 ALLOY, HEAT TREATED TO 95,000 PSI MINIMUM SHEAR. BOTH RINS USE HS60M R MONEL COLLARS.

* HI-SHEAR TRADEMARK REGISTERED U.S. PAT. OFF. CE U.S. PATENTS 2,888,874; 3,356,680; 3,158,676; OTHER U.S. AND FOREIGN PATENTS PENDING.

*X-15 .. A CHALLENGE FOR FASTENERS

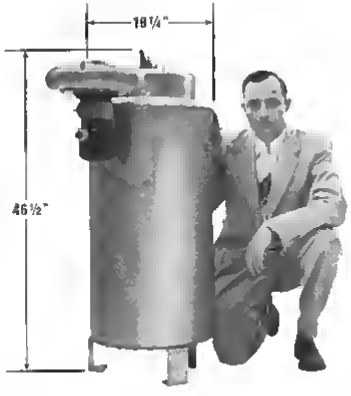
The X-15 research vehicle is ready for the first manned probe into space ... with speeds exceeding 3600 mph ... for altitudes above 100 miles ... to withstand 1200°F.... a challenge for fastening techniques.

The selection of the Hi-Shear rivet for use in the X-15 is an outstanding example of how this and other high strength fasteners are being developed at Hi-Shear research facilities to keep pace with the ever changing requirements of the aircraft and missile industries.

The Hi-Shear rivet *still* offers the *lightest strength-weight ratio* of any swaged type fastener, simplicity of installation and service reliability established by sixteen years acceptance by industry.

Contact your Engineering Standards Group or write to us for specific fastener data.

hi-shear RIVET TOOL COMPANY
2600 WEST 247TH STREET • TORRANCE • CALIFORNIA



million btu/hr!

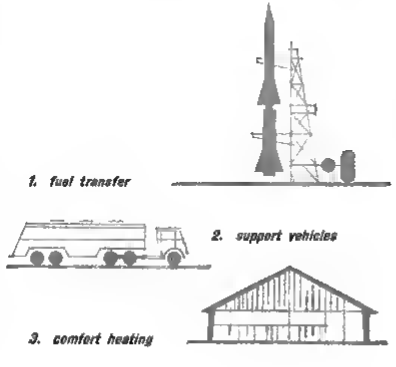
For missile ground support applications this compact new Janitrol liquid heater delivers heat up to a rate of 1 million Btu/hr. A complete variable output heating system, it automatically maintains liquid at any desired temperature . . . reliably.

This 257 pound package is ideally suited to such applications as heating missile fuel during storage and transfer, vaporizing liquids and in a wide variety of support vehicles and buildings. For both material and personnel comfort heating the new Janitrol liquid heater is a simple, trouble-free way to get large quantities of controlled heat.

Heater burns either diesel fuel, gasoline, or JP-4, and can be converted with a simple adjustment. Radio noise shielding meets military specifications. It will operate in extreme environments to −65°F.

Janitrol's new liquid heaters may be used individually, or in multiples to meet virtually any heat requirement.

Wherever heat is needed in missile support equipment Janitrol may already have what you need. Contact your Janitrol representative now for the full story on liquid heaters. Janitrol Aircraft Division, Surface Combustion Corporation, Columbus 4, Ohio.



JANITROL

pneumatic controls • duct couplings & supports • heat exchangers
combustion equipment for aircraft, missiles, ground support

SIKORSKY says AMP

The electrical harness being assembled in the upper right photograph is part of the new Sikorsky S-62 helicopter. Through this "central nervous system," the pilot operates all electrical/electronic components of the aircraft. And, dozens of A-MP terminal products are used to terminate and connect this vital "central nervous system."

There are several good reasons why A-MP terminal products are used in the "central nervous system" of today's aircraft: engineers remark *reliability;* plant superintendents note economy—*in both time and money;* assembly line employees say *easy installation,* and inspectors add *no rejects.*

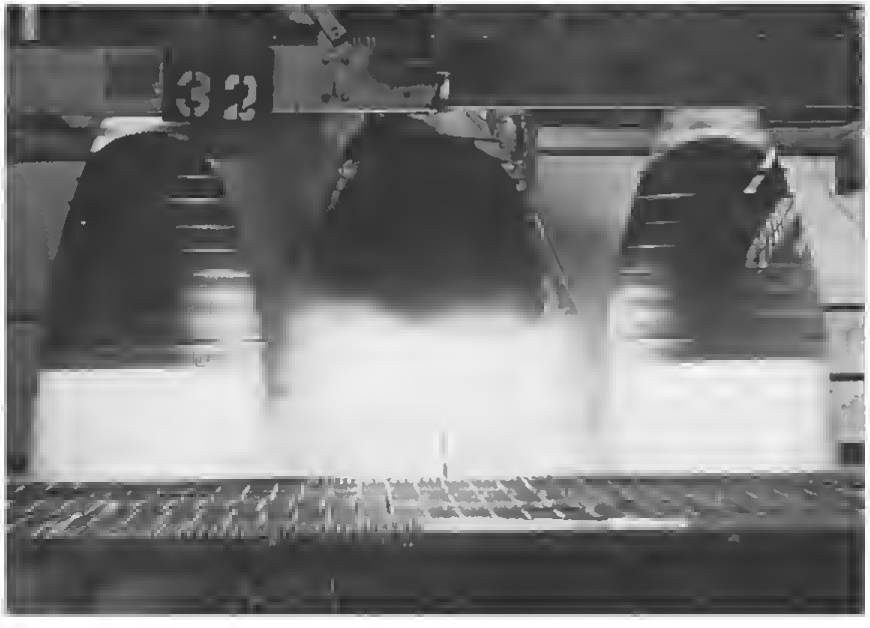
A-MP products will meet your exacting circuitry requirements and save you money on total installed costs.

Write for more information on the unbeatable reliability and economy of our circuitry termination method

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through subsidiary companies in Canada • England • France • Holland • Japan



Special Solar skills for advanced missile systems

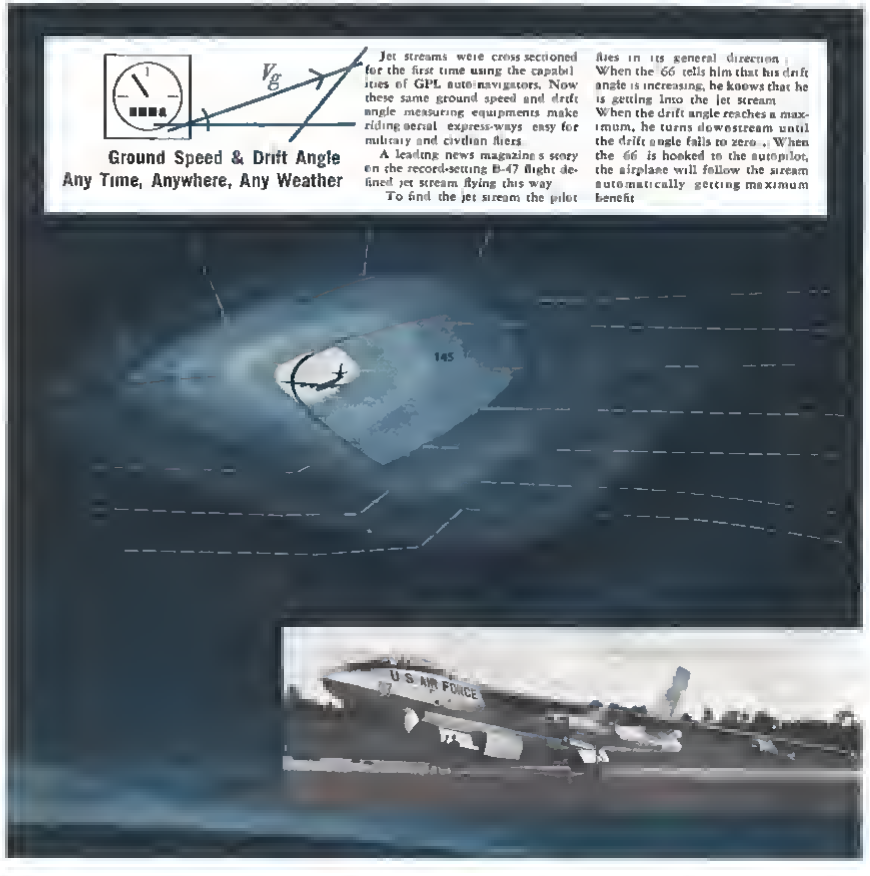
Powerful Rocketdyne booster engine chambers—designed to withstand combustion temperatures of 5500 F—are being fabricated by Solar. The chambers are an outstanding example of Solar's advanced technology in the missile systems field. Made from hundreds of spaghetti-like nickel or stainless steel tubes, they are precision fabricated and brazed together to form nozzles. A large sustainer engine plus the twin-chambered booster engine make up the liquid propellant power system for the giant Atlas ICBM.

Solar's leadership in high-temperature technology—*plus advanced facilities*—is one part of the company's outstanding missile and weapon systems capability.

Complete engineering, research and test facilities—staffed by a team of systems engineers participating in America's most challenging missile and space programs—are available to help solve your difficult design, development and production problems. Write for details to Dept. F-112, Solar Aircraft Company, San Diego 12, California.

SOLAR
AIRCRAFT COMPANY
SAN DIEGO
DES MOINES

ENGINEERS WANTED! CHALLENGING PROJECTS, UNLIMITED OPPORTUNITIES, GOOD LIVING WITH SOLAR. WRITE TODAY!



Cross-section of a headline

Headlines were made the day a GPL auto-navigator guided a USAF B-47 into the jet stream over California, set her down only 3 hours and 47 minutes later in sight of the Atlantic!

This dramatic use of GPL Doppler Navigation Systems is just one application of their basic function — precise point-to-point navigation — any time, anywhere, any weather. The systems work without ground aid or celestial fixes, have proved themselves over many millions of operational miles. They offer military and civilian pilots continuous, accurate navigation information, including velocity.

RADAN* Navigation Systems, recently released for civilian use, are now available to everyone. They save precious time and fuel for the air lines, provide a priceless margin of safety for all.

GPL | GPE
GENERAL PRECISION LABORATORY INCORPORATED, Pleasantville, N. Y.

*Trademark

ENGINEERS—GPL achievements have opened up some unusual research and development opportunities. Send resumé to Personnel Manager.

January 19, 1959

Aviation Week
Including Space Technology

Vol. 70, No. 3
Member ABP and ABC

EDITORIAL OFFICES New York 36—330 W. 42nd St. Phone: LOngacre 4-3000 (Nights, LO 4-3035) Washington 4, D. C.—National Press Bldg. Phones: NAtional 8-3414, REpublic 7-6630 Los Angeles 17—1125 West Sixth St. Phone: HUntley 2-5450 Dallas 1—1712 Commerce St. Phone: Riverside 7-5117 European Office—1 rue du Temple, Geneva, Switzerland, Phone: 32-35-63

COVER: Convair Atlas intercontinental ballistic missile 9B is launched at Air Force Missile Test Center, Patrick AFB, Fla. Missile was programmed for a flight of slightly more than 3,000 mi. but, because of an early burnout of the sustainer, range achieved was only 2,300 mi. Eleven days later, on the next launch of the Atlas, the missile was programmed for a full range 6,300 mi. flight and achieved it (AW Dec. 8, p. 29)

PICTURE CREDITS
Cover—USAF; 28—Wide World, UPI; 33, 36—USAF; 34—French Air Ministry; 37—Convair; 38—Eastern Air Lines; 39—Armstrong Whitworth; 48, 49—S. B. Kramer; 68, 69—Aviation Week; 96—University of Iowa; 97—Developmental Engineering Corp.; 103—Permanent Filter Corp.

75,381 copies of this issue printed

EDITORIAL

Major USAF Command Shifts Loom

A series of shifts in command of major USAF field organizations is imminent. It will be triggered by the retirement of a trio of USAF four-star generals, beginning with Gen Edwin W Rawlings who has been a fixture as head of the Air Materiel Command for the past eight years. Gen Rawlings, who has done an outstanding job in modernizing USAF procurement and maintenance operations, will retire from his AMC post shortly to enter private business. He will be followed out of USAF by Gen Earle E "Pat" Partridge who is ending a distinguished military career as chief of the North American Air Defense Command and Gen O P Weyland, who has been struggling valiantly with extremely limited resources to mould Tactical Air Command into a mobile striking force capable of quick response to international crises.

In the shifting of current USAF three-star generals to fill these promotion vacancies it is certain that changes in command will be made in the two organizations that are most vital to the aviation industry and its related technologies and on whom their future effectiveness depends—Air Materiel Command at Dayton and Air Research and Development Command at Andrews Field, Md.

Since no announcement on these shifts was made at the recent USAF Commanders' Conference in Puerto Rico where Gen Rawlings made his formal farewell to his peers we conclude that these new appointments are being given more than normal scrutiny and study. We certainly agree with whoever is going over the USAF general officer talent available for these posts with an extraordinary fine mesh screen before making final selections because they are—with the possible exception of the Strategic Air Command—the most important posts in determining not only the future of the Air Force, but also the effective military posture of this nation in the critical years ahead.

These posts obviously cannot be filled by routine considerations of seniority or military tradition. They demand a careful selection of the best available men regardless of seniority and other purely traditional considerations. They need men who have had intimate contact with the technical revolution of the past decade and all of its challenging implications for the future men who have supplemented their military duty with practical experience in dealing with the industrial and financial complexes of private industry, and men who have the courage and energy to discard useless tradition and continually break new ground in establishing new military patterns of the future.

There should be little doubt at this late date in the post war technological revolution, with its fierce challenge to our leadership from the Soviet Union, that an even more effective relationship must be developed between our military services and the scientific, industrial and financial resources on which they are dependent for new weapons development.

Among all of the USAF officers available for either the AMC or ARDC command posts, the superior qualifications of one stand out in bold relief like the Washington Monument from its surrounding Mall. This man is Lt Gen C S "Bill" Irvine, now deputy USAF chief of staff for material.

Bill" Irvine has had an amazing career at USAF, beginning as an enlisted pilot-instructor in 1918 and rising to three-star rank. Almost from the beginning of his long service, he has concentrated heavily on the technical aspects of the Air Force, although his reputation as a pilot of heavy aircraft is second to none.

Gen. Irvine's experience with what is now AMC dates back to 1932 when he was chief of the Powerplant Laboratory at Wright Field. He was a key man in planning and trouble shooting the vast production, maintenance and modification operations of the early World War II years, particularly on the B-17 and B-29 bombers. "Bill" Irvine followed the B-29 into combat operations with the Twentieth Air Force in the Pacific where he won his first Distinguished Service Medal.

His post-war career included command of USAF's first nuclear-armed bomb group, and he organized the logistics of the newly created Strategic Air Command as its deputy chief of staff in 1947-48. He earned his second star by taking over SAC's first B-36 wing at a time when all of its aircraft were grounded due to mechanical problems and whipping it into such shape that only six months later he got 150 hr. of operational flying time in a single month from a single B-36. He also confounded B-36 performance critics by flying this bomber on a 10,000 mi. nonstop mission from a U S base and dropping a 10,000 lb. bombload on Eniwetok 5,000 mi. from his takeoff point. His reputation as a successful technical troubleshooter was such that in 1952 he was sent to Air Materiel Command as deputy commander to Gen Rawlings to handle the growing problem of B-47 production and maintenance. He also has developed an enviable reputation for developing outstanding junior officers in the intricacies of the development and procurement business. In his present post, "Bill" Irvine has spearheaded the advance of USAF in the development and procurement of missiles and space vehicles.

But beyond these formal achievements, "Bill" Irvine's greatest asset is probably his personal knowledge of almost every nook and cranny of the U S defense industrial complex, its technical capabilities, the quality of its management and its record of performance under fire. In turn, he has earned the confidence and respect of the industry for his effective, if often blunt and unorthodox, methods of getting results when the need is critical.

He will shortly complete 40 years of military service and could easily retire to an industrial post. It would indeed be tragic if his energy, capability and reputation were not put to further work on USAF's key technical problems.

Air Materiel Command has an urgent need to accelerate and expand its basic modernization begun by Gen Rawlings. This problem is even more acute now due to the swift time factor of modern war and the complex arsenal of missiles, aircraft and space vehicles USAF must maintain. Air Research and Development Command badly needs to trim its accumulated administrative fat, strip down to the lean action organization it once was and become again the driving spearhead of military technical progress. It also needs to stop running scared in the face of new agencies such as ARPA and NASA and have the courage and intelligence to do the USAF research and development job effectively.

—Robert Hotz

WHO'S WHERE

In the Front Office

Russell S Kenerson, president, Thompson Products Ltd , a subsidiary of Thompson Ramo Wooldridge, Inc St Catharines, Ontario, Canada Mr Kenerson succeeds George A Stanfer, now board chairman

Pursuant to the pending merger of Metals & Controls Corp., Attleboro Mass into Texas Instruments, Inc , Dallas, Tex. **C. L. Thomsen** has been elected president of Metals & Controls Mr Thomsen succeeds **G L Williams** who continues as director and treasurer

Walter A Hensel, president, Datagraphic Systems, Inc , Santa Monica, Calif Also **Russell S Ellsworth, Francis Nivens** and **J. Edwin Coates**, vice presidents, and **James T McMillan**, secretary treasurer Mr Ellsworth also continues as general manager

Raymond C Haylock, vice president and general manager, Chance Vought Aircraft, Inc , Dallas Tex , and **Gifford K Johnson**, vice president business planning Mr Johnson also elected president of Vought's subsidiary, Geneyes Corp Other Vought appointments **J. R Clark**, director of engineering, **D G Gilmore**, director of production, **Forbes Mann**, director of sales and service

Gerald E Donovan, chief financial officer Douglas Aircraft Company, Inc., Santa Monica, Calif

J. Louis Reynolds, vice president and assistant to the president, Marquardt Aircraft Co , Van Nuys Calif Also **Don L. Walter**, vice president of Marquardt's Power Systems Group

Robert E Hage, vice president, McDonnell Aircraft Corp , St Louis, Mo , and general manager of the newly formed Aircraft Transport Division

Dr Allen E Puckett, a vice president and director of the Systems Development Laboratories Hughes Aircraft Co., Culver City Calif Also **Robert J. Shank**, vice president systems management **Dr Nathan I Hall** succeeds Mr Shank as vice president-engineering

H L Thackwell, Jr , has been assigned to organize and develop a Space Propulsion Division for Grand Central Rocket Co Redlands, Calif

Newton A. Lieurance, Chief Weather Division Development Directorate Bureau of Research and Development Federal Aviation Agency Washington, D C

Maj Gen Alvin R Luedecke (USAF ret) general manager Atomic Energy Commission, and **Paul F. Foster**, deputy general manager Gen Luedecke is former commander of Joint Task Force Seven Operation (Hardtack)

Honors and Elections

Prof. Theodore von Karman has accepted the Victor Emanuel Visiting Professorship at Cornell University for the spring term of 1959

Frederick B Lee, director of the Olin Mathieson Chemical Corp., has been elected to the board of governors of the Flight Safety Foundation

(Continued on page 113)

INDUSTRY OBSERVER

► Aerojet-General is working on colloidal particles for electrical propulsion Some of the particles, which would be approximately 1,000 times the size of atoms, might be charged negatively, others positively in order to prevent "space charge effect," one of the problems in ion propulsion When charge is uniform, vehicle may assume the opposite charge, making expulsion of the propulsion mass difficult

► One phase of Air Force electronic countermeasures research is development of a single type of chaff which can protect aircraft against radars operating at frequencies anywhere between 10 mc. and 11,000 mc USAF chaff research already has reduced the number of different chaff packages required to cover this frequency spectrum from the six needed in World War II to only three types Air Force also hopes to reduce size and weight of air-dispensed chaff package from present 77 cu in and 2.6 lb to only 30 cu. in. and one pound

► Air Force in the future will not procure fighters with less than two engines Better probability of survival and more reliability offered by multi-engined designs are considered essential because of the high cost and performance of upcoming designs Same policy is favored by Navy

► Navy plans a 3,000 mi version of its Polaris fleet ballistic missile as a follow-on to the 1,500-mi. version now under development Longer range would put all of the world's land mass within potential range of a Polaris submarine, allow the submarine to remain farther at sea on attacks against inland targets Designation of the longer-range version is AP-2

► One proposal for salvaging the Navy-Martin Vanguard satellite launching vehicle is to change the name, use the General Electric first stage engine in combination with an improved solid propellant engine similar to the Grand Central or Allegany engines now planned for the third stage and launch small lightweight, minimum length instrumented satellites

► Radiation dosages in the 500 to 5,000 roentgen range, which produce quick death or incapacitation in humans, travel eight to 17 times farther when a nuclear explosion occurs in space than they do at sea-level. Lethal range of multi-megaton warheads fired in space may be hundreds of miles, making considerably heavy shielding a consideration for military space vehicles.

► Explosion of nuclear warheads fired to high altitudes by missiles over Johnston Island in the Pacific last Aug 1 and 12 produced disruption in high-frequency communications similar to the disruptions caused by giant solar flares Most commercial communication systems in the Pacific operating from about 5 to 25 mc noted substantial disturbances Those within a few hundred miles of Johnston Island experienced outages for as long as several hours at various times over a period of about 1 day

► Proposal to use turbofan-powered Model 600 transport for electronic countermeasure service and training with capability of accommodating 16 positions (AW Feb. 17, p. 63) has been made to Air Force by Convair San Diego Division of General Dynamics Corp. Meanwhile, company is converting a Model 240 for Air Force ECM training

► Size of shipping container for General Electric J93 Mach 3 turbojet engine indicates that it is approximately seven and one-half ft. long, six ft in diameter The turbojet is being developed under Air Force contract for the North American B-70 bomber and F-108 interceptor

New Army 105-mm non-recoiling rifle developed by Frankford Arsenal in Philadelphia, with a rotating breach permitting firing of five shells in 12 sec. and capable of piercing 21 in armor, is being studied for use with Transportation Research & Engineering Command's aerial platforms and other aircraft Army R&D chief, Lt. Gen. A. G. Trudeau, recently inspected mockup installation of the experimental weapon on Piasecki VZ-8P, mounted on a tripod next to the pilot's seat Final installation would provide gun with limited degree of traverse and deflection and elevation with tracking and firing being done electronically.

Washington Roundup

Gag Attempt Backfires

Rep. Daniel J. Flood (D-Pa.), a member of the House Defense Appropriations Subcommittee, last week introduced legislation that would abolish the Bureau of the Budget under the Executive Branch and create a new U.S. Budget Office under the Legislative Branch. Introduction of the bill followed Flood's disclosure that Defense Department officials have been warned not to disagree with the President's Fiscal 1960 budget which will be presented to Congress today. The order, Flood said, was contained in a secret memorandum to the Defense Department signed by Budget Director Maurice H. Stans.

The directive warned that officials testifying before Congress should not ask for more funds for defense than requested by the President. "Executive Branch personnel are expected to support the President in his budget recommendations, according to the memorandum as supplied by Flood. "It is expected that witnesses will carefully avoid views differing from the budget, either on the record or off the record."

Flood denounced the memorandum as a shocking attempt to impose a gag rule on Defense witnesses.

Challenge to Nixon

In another area, Sen. Stuart Symington (D-Mo.) called upon Vice President Richard Nixon last week to clarify his and the Administration's appraisal of just where the U.S. stands in comparison with Russia in the ballistic missile field. The Senator made his request following conflicting reports concerning a vice presidential comment in evaluating the U.S. and Russian programs. A number of newspapers quoted Nixon as saying the U.S. is ahead of the Soviets in ballistic missiles and that while behind in the over-all missile race, it is closing the gap at a fairly rapid pace. Later, friends of Nixon were quoted as saying that the Vice President had been misquoted.

Symington replied that he did not know a single impartial expert in the missile field who would support such an evaluation and he asked the Vice President to make public, in percentages, the number of operational intercontinental ballistic missiles the U.S. will have at the end of the year vs. the estimated number the Soviets will have. He added that, if Nixon did not release the percentages by the end of the week, he would do so himself.

Missile Management

The military subcommittee of House Government Operations Committee is expected to make an investigation of the management of military ballistic missile programs its first order of business this session. The group, headed by Rep. Chet Holifield (D-Calif.) probably will start off with hearings on a report on management of Air Force's ballistic missile program by the USAF Inspector General (AW Nov. 24, p. 34), and later go into the programs of the other services.

General Accounting Offices' comprehensive investigation of the USAF program, launched when USAF refused to release the complete Inspector General report, will not be completed for another few months. GAO claimed it had authority in law to obtain the report, but the President sided with the Air Force (AW Nov. 24, p. 34).

CIA Watchdog?

Congressional support for a watchdog committee over Central Intelligence Agency also is developing. A number of congressmen introduced legislation establishing such a committee the opening week of the session. CIA is the only government agency that does not report to any congressional group. Other agencies have two types of congressional overseers—a legislative committee (such as Armed Services or Commerce) and an appropriations committee which scrutinizes budgets annually. CIA's operating budget is unknown. Funds are transferred to it by the President from discretionary funds.

Airline Labor

Congress is in the mood to enact new airline labor legislation as a result of the rash of Christmas-season strikes (see page 41).

- Sen. Spessard Holland (D-Fla.) wants compulsory arbitration of disputes and a ban on strikes and lockouts—an approach generally opposed by both management and labor but favored by Eastern Air Lines' board chairman E. V. Rickenbacker.
- Sen. Thruston Morton (R-Ky.) wouldn't go this far, urges an improvement in settlement machinery "so that the strike will indeed be a last resort."

Meanwhile, Airline Personnel Relation Conference of Air Transport Assn. is attempting to work out an industry-wide policy on new labor legislation. Recommendations are scheduled to go to ATA's board of directors this week.

Doolittle Cuts NASA Ties

Dr. James H. Doolittle plans to resign from the nine-man National Aeronautics and Space Council, governing body of the National Aeronautics and Space Administration to avoid any possible conflict of interest with his new post as chairman of the board of Space Technology Laboratories. Dr. Doolittle, chairman of NASA's predecessor, the National Advisory Committee for Aeronautics, also plans to drop his membership in a number of other advisory groups and will actively participate in only two—the President's Board of Foreign Intelligence and the advisory board of the National Air Museum.

Japan Bilateral

U.S. and Japan last week exchanged notes to conclude negotiations that began in April, 1958, on an amendment to the 1953 bilateral air agreement between the two countries. Under terms of the amendment, Japan Air Lines may now operate to Los Angeles from Tokyo as well as to Seattle and San Francisco as first reported by AVIATION WEEK (Nov. 24, p. 45). All three points are to be treated as coterminals. Japan also was granted unlimited rights to fly beyond Los Angeles instead of San Francisco on its route to South America from Tokyo.

JAL will begin its Los Angeles service in May with three weekly flights. It will open its North Pacific route between Tokyo and Seattle for the first time with bi-weekly flights beginning in June. Survey and familiarization flights on this route will be conducted for one week beginning Jan. 30 via Shemya, Cold Bay, King Solomon and Anchorage. Present daily service to San Francisco will be maintained.

—Washington staff

Soviets Prepare to Put Man into Space

By Evert Clark

Washington—Soviet scientists may soon announce the successful return of a human passenger from a rocket flight, according to a Rand Corp report prepared for the House Select Committee on Astronautics and Space Exploration.

"It is reasonable to assume," the report said, that the feat will be accomplished 'soon' based upon the Soviets' extensive studies in the various aspects of space medicine and their patent desire to be first to achieve manned space flight."

Rocket flights to the vicinity of Venus and Mars also are entirely possible after a successful lunar impact," according to the report which was written before Russia launched its Mechta rocket to within 5,000 mi. of the moon (AW Jan. 12, p. 26). Earliest favorable dates for planetary shots are June 8 of this year for Venus and Oct. 1 of next year for Mars.

The report was issued by the committee as a guide to the space age under the title "Space Handbook: Astronautics and its Applications." It is based upon an earlier classified report prepared for the committee by Rand and discusses fundamental problems of space technology and U.S. and Soviet capabilities.

Other indications of Soviet space progress mentioned in the Rand Corp report:

- **Soviets** "are quite aware of the importance of recovering photographic film, instruments and animals from satellites" and have discussed general recovery techniques and indicated the existence of various recovery projects. One involves ejection of a 209 lb. package from a satellite or carrier rocket at perigee. Package consists of an 11.9 lb. retrorocket and a 3.5 lb. stainless steel collapsible sphere. When the sphere is inflated with helium it measures 3 ft. in diam. and acts as a drag brake. It brings an 8 oz. cartridge of exposed film and a small beacon transmitter to earth within 20 min. after leaving the orbit. Terminal velocity is 29.5 fps.
- **Single stage research rocket** has lifted a 3,720 lb. payload to a height of 279 mi. (AW Nov. 3, p. 61). This rocket carried two dogs in a pressurized capsule and was stabilized in all planes. Dogs were recovered successfully.
- **Perigee altitudes for the three** Soviet Sputniks were 140-141.3 mi., 139.5 mi. and 140 mi. while apogees were 587, 1,036 and 1,166 mi. respectively, according to Soviet reports. "The almost identical values of perigee altitude may indicate that a fairly good guidance system has employed by the Soviet scientists in placing these satellites into orbit, although not necessarily one suitable for ICBM use." The report said.
- **Launching site for Sputnik I** and Sputnik II is in the Kyzyl Kum desert at a spot with approximate coordinates of 42½ deg. N and 65 deg. E or about 248 mi. southeast of the Aral Sea. The estimate is based upon intersection of the traces of the orbits and from elements of the orbits determined by observations in Japan. Prof. Tadao Takenouchi, of the University of Tokyo Astronomical Laboratory, places launch times at 1921 hr. Greenwich Mean Time Oct. 4, 1957, for Sputnik I and 0232 hr. GMT Nov. 3, 1957, for Sputnik II on the basis of periods and initial transit times over Moscow, which were published by Tass.
- **Mass of Sputnik II** must have been in the neighborhood of 4.4 to 6.6 tons. This satellite carried the dog Laika and remained attached to the last stage rocket. Dimensionally this satellite-plus rocket must have been about the size of the ballistic rockets displayed in Red Square in the Nov. 7, 1957, parade—or about the size of the Army's Redstone rocket.
- **Soviet ICBM** has a guidance system which Russia claims will place a missile on target with an error not exceeding .002 of the range. Last stage engine accelerates the ballistic rocket to its assigned velocity in an 'ethereal gun-barrel' or 'tunnel' formed by radio beams from three or four ground radio stations. Radio signal shuts off the last stage engine when the rocket reaches the predetermined speed.
- **Soviets increased** V-2 rocket engine thrust from 55,000 to 77,000 lb. by increasing propellant flow rate, developed an engine of 265,000 lb. thrust and probably have developed a 551,000 lb. thrust engine as an improvement on the powerplant envisioned for the German A-10 rocket.
- **Although most of the German** rocket workers taken to Russia from Peenemunde at the end of World War II were repatriated in 1952, a group of electronic experts was not repatriated until 1958.
- **"Soviet confidence** ... is reflected in the fact that, whereas originally enthusiasts exhorted Sputnik observers—professional as well as amateur—to send their tracking data to Moskva-Sputnik, they now ask that data be sent to Moskva-Kosmos."

Planetary Flights

Most Favorable Launching Dates*

Earth to Mars	Earth to Venus
Oct. 1, 1960	June 8, 1959
Nov. 16, 1962	Jan. 13, 1961
Dec. 23, 1964	Aug. 16, 1962
Jan. 26, 1967	Mar. 28, 1964
Feb. 28, 1969	Oct. 27, 1965
	June 5 1967
	Jan. 11, 1969

*Note: Launchings are not limited to these dates but launch velocity required increases with each day of postponement.

Source: 'Space Handbook, Astronautics and its Applications,' prepared by the Rand Corp. for the House Select Committee on Astronautics and Space Exploration

Rand Defines Satellite Potential

By Philip J. Klass

Washington—Potential advantages of using satellites for bombing platforms, military reconnaissance, navigation, communications and for obtaining meteorological data—and the problems involved in developing such satellites—are realistically appraised in the new "Space Handbook" prepared by the Rand Corp.

One of the most attractive features of using satellites as bombing platforms, the report says, is the fact that they could be launched at a leisurely pace long before the outbreak of hostilities without arousing undue suspicion. Upon receipt of a master "bombs away" signal, all satellites would "drop" their warheads.

To launch a warhead from an orbiting satellite, however, requires use of retrorockets to decelerate the weapon. If the warhead is to descend essentially straight down, the decelerating propulsion requirement is "very severe indeed," the Rand handbook points out. If a long ballistic trajectory is used, the deceleration problem becomes far easier to solve.

For example, to achieve a 5,500-mi. descent from a satellite orbiting at 300 mi. requires deceleration of the warhead by only 1,000 fps. which is equivalent to speed achieved by 75 mm. field gun projectile fired with reduced charge to cover range of about 7,000 yd.

However, long ballistic trajectory for warhead poses serious aiming and guidance problems, Rand points out. For example, an error of only 0.01 deg. in azimuth will result in a one nautical mile miss at 5,500 mi. Developing satellite attitude and heading references with such accuracies for long periods of time after launch would appear to be a formidable task.

Reconnaissance Satellites

Use of satellites for military reconnaissance has the important advantage of being able to cover large areas rapidly but retrieving the information from the satellite poses serious problems. Another problem arises because many important objects of military interest are getting smaller—as, for example, a missile launching site, compared with an airfield—which demands extremely high resolution. Difficulty in obtaining the required resolution for precise military reconnaissance is increased by the fact that satellites will operate at altitudes that are 15 to 100 times greater than those of present photo-reconnaissance aircraft.

These requirements suggest the use of cameras and film which must be automatically developed aboard the satellite. Film might then be electronically scanned, using television techniques, and the data transmitted to earth via radio.

However, the satellite would require 22½ min. to transmit the information that can be stored on a single 9 x 9 in. photograph with a resolution of 100 lines per millimeter, assuming its transmitter has a bandwidth of six megacycles. This is roughly equivalent to a commercial television station in terms of electric power and airborne equipment weight required. Furthermore, if satellite is orbiting at 300 mi. altitude it will remain in sight of a ground station for only 10 min., Rand points out. At 1,000 mi. altitude it would remain in view of the ground station for 20 min.

A typical reconnaissance satellite operating at 150 mi. altitude might scan an area of about three million square miles per day, producing 1,500 ft. of 9 in. wide film. If resolution of 100 lines per millimeter is required to permit resolution of earth objects to within 50 ft., the satellite would require more than a month to radio back the information it collects in a single day.

This suggests that large-area reconnaissance satellites will have to drop their film in suitable data capsules which must subsequently be recovered on the earth.

Tiny reconnaissance satellites used to detect mass firings of enemy ballistic missiles, however, the delays involved in recovery of data capsules would prove intolerable.

For this type of specialized data, radio transmission probably will be used, Rand says.

"The report points out that photo reconnaissance equipment now used in aircraft operating at altitudes of 50,000 ft. weighs several hundred to several thousand pounds. At satellite reconnaissance altitudes, size and weight of equipment will 'grow sharply' to provide equivalent detail. This, Rand says, indicates future recon satellite payloads on the order of 50 tons. Report also acknowledges that the Van Allen radiation may cause fogging of photographic film unless considerable shielding is used in satellite and data capsule.

Another solution to this problem would be to convert camera image into electrical signal and store it on magnetic or electrostatic tape, at some sacrifice in resolution or in equipment weight.

As weather observing tools, satellites appear to offer a new dimension in the field of meteorology, the Rand report says. In providing an opportunity to view the earth as a whole in a very short period of time.

Initial efforts will be devoted to using optical and infrared sensors to obtain a rough outline of the location of cloud cover about the earth. While cloud cover data alone cannot provide precise weather information, it can fill serious voids in present weather data from large portions of the oceans and less populated areas.

Resolution required of a meteorological satellite is far less than that needed by a military recon satellite, greatly relieving size and weight of airborne equipment.

More sophisticated meteorological satellites using infrared and other electromagnetic measurements for observing the earth's atmosphere may enable scientists to measure temperatures

Miss Distances

Effect of 1 fps. error in velocity at cutoff

Destination	Miss (n. mi.)
Point on earth (5,500 n. mi. ICBM)	1
Moon	20-100
Mercury	40 000
Venus	25 000
Mars	20 000
Jupiter	65 000
Saturn	200,000
Uranus	700 000

Source: "Space Handbook: Astronautics and its Applications," prepared by the Rand Corp. for the House Select Committee on Astronautics and Space Exploration

Summary of Current and Expected Payload-Weight Capabilities

(All payload weights shown in pounds)

ITEM	VANGUARD	JUPITER C	THOR/ JUPITER	ATLAS/ TITAN		
Weight	22 000	50 000-50 000	100 000	200 000		
Thrust	28 000	75 000	180 000	800 000	1 500 000	3,000 000
300-mi satellite	20	15-20	700-2 000	2 000-8,000	37 000	75 000
22,400-mi (24-hr.) stationary satellite			25-600	600 2 500	11,000	22 000
Moon impact [circumlunar]			80 800	800 3 000	13 000	25 000
Moon satellite			15 500	300 1 500	8 000	13 000
Moon landing			10-500	200 1 000	4 000	8 000
Venus/Mars flight			25 600	500 2 500	12 000	23 000
Jupiter flight			10 400	600 1 500	2,000	5 000

Source: "Space Handbook: Astronautics and its Applications," prepared by Rand Corp. for House Select Committee on Astronautics and Space Exploration

Satellite Decoys

Washington—Inflatable metallic balloons a useful scientific tool for measuring atmospheric density, might be used by an enemy to saturate intercontinental ballistic missile defenses and easily warning radars or accidentally trigger off a major war, Rand Corp.'s "Space Handbook" points out. Balloon satellites that can simulate an ICBM nose cone "suggest some potentially serious implications for warning systems and retaliation policy," Rand report cautions. A faulty launch of an ICBM carrying several hundred inflatable balloon satellites intended for peaceful scientific purposes could create the appearance of a mass ICBM attack on early warning radars.

at various altitudes in the atmosphere, according to Rand. This may make it possible to determine quantities of various gases in the atmosphere which, in turn, may permit more accurate weather forecasting.

For maximum usefulness, meteorological data obtained by a satellite should be received on earth in an hour or less. This Rand says, suggests a rather elaborate network of data recovery stations on earth which could receive data radioed back from satellite and instantly relay it to a weather bureau.

Desirable objectives for future meteorological satellite development include capabilities for measuring cloud motion relative to the earth atmospheric temperatures, total moisture content, total ozone content and total solar radiation flow into and out of the atmosphere.

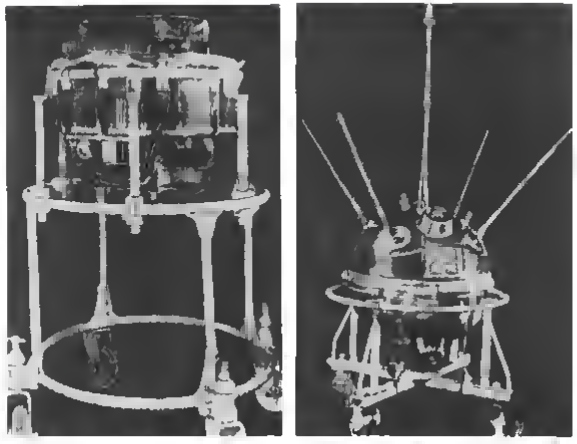
Rand says it is "conceivable that, in the not so distant future, satellites may actually supplant a part of our present weather network."

Two different types of navigation satellites for use by terrestrial vehicles and aircraft in establishing their position are described by Rand scientists in the report. Both are predicated on the ability to accurately predict the position of the satellite in its orbit. The report points out that at fairly high altitudes such as that of Vanguard I, orbit can be predicted with an error of less than 5 mi. for at least a few days in advance, increasing to "some tens of miles" after a month. Orbit predictions for low-altitude satellites, such as Explorer IV, are useful for only about one day in advance, according to Rand. Predictions a few hours in advance would be in error by less than a mile. With increased knowledge of atmospheric density and improved techniques for calculating orbits, this accuracy might be improved.

The two types of navigational satellites suggested are:

• **Spherecographical.** Satellite would carry a small transmitter, while the terrestrial vehicle would be equipped with what in effect is an electronic sextant—a highly directional antenna and receiver to determine attitude angle from vehicle to satellite, a vertical reference and an accurate clock. Celestial navigation techniques would then be employed to establish two intersecting lines of position.

• **Doppler shift.** Satellite would be equipped with a small radio transmitter designed to transmit its signal with very stable frequency. Terrestrial vehicle would carry a sensitive radio receiver, accurate frequency reference and accurate clock. By determining the instant of minimum Doppler frequency shift, navigated vehicle can determine time when satellite is nearest vehicle. By establishing rate at which Doppler shift occurs vehicle can determine its bearing relative to satellite path.



INSTRUMENT package (left) and instrument container for Russian probe are on dollies.

Soviets Detail Lunik Instruments

Moscow—Instruments for Russia's moon rocket, which the Soviets now say passed within 3,100-3,700 mi. of the moon instead of 4,660 mi. (AW Jan. 12, p. 26) were housed in container consisting of two thin hemispherical aluminum magnesium alloy shells.

The shells are hermetically connected by frames with a packing of special rubber. An instrument holder, a magnesium alloy tubular design, is fastened on the frame of the lower half shell and the instrument package mounted upon it.

Four antenna rods for the transmitter on the 183.6 mc. frequency for controlling the trajectory of the rocket are placed on one of the half shells. They are fastened on the body symmetrically relative to a hollow aluminum pin, at the end of which is a magnetometer.

A protective cone against heating in the atmosphere is used, and until this is discarded the antennas are folded and fastened onto the pin. Antennas are extended when cone is jettisoned.

Two proton traps for detecting the gas components of interplanetary matter and two Piezo gages for detecting meteorite particles are mounted on the same half shell. Silver zinc and oxidized mercury batteries provided power.

The instrument container was filled with gas at a pressure of 1.3 atmospheres and the gas temperature was maintained at about 20C. According to the report in the Russian newspaper Pravda, this temperature regime "is ensured by imparting through special treatment to the container shell definite coefficients of reflection and radiation."

In addition," the report said, "a ventilator for forcible circulation of gas is installed in the container. Gas circulating in the container draws off heat from the instruments and passes it out to the shell which serves as a sort of radiator."

The tracking network included a group of automated radar stations, used to determine efficiently the initial flight path and to issue long term forecasts of rocket's velocity and trajectory to measurement and observation instruments.

Sodium cloud was used as a means of checking the probe's flight path. Main unit of the equipment for it was a sodium evaporator designed to evaporate 1 kg. of sodium in 5-7 sec. An electronic device, whose main unit was a quartz clock, signalled the evaporator to switch on and the discharge took place at an altitude of 70,000 mi.

HAMMER and sickle emblem and words "USSR January 1959" are on container.

Soviet Nuclear Plane Possibility Conceded

By Ford Eastman

Washington—Existence of a new and "unusual" type aircraft in Russia "suitable" for nuclear power was conceded by government officials at an executive session of a joint congressional subcommittee on atomic energy.

The disclosure was made at a briefing of the Research and Development Subcommittee by representatives of the Central Intelligence Agency, Defense Department, Air Force and Atomic Energy Commission almost six weeks after AVIATION WEEK published an exclusive report that Russia had begun initial flight testing of a nuclear powered bomber (AW Dec. 1, p. 27).

The meeting was called by the subcommittee to determine the authenticity of the Russian nuclear aircraft report and to review Soviet progress in the aircraft nuclear propulsion field as compared with the U.S. program. Details were withheld from the public.

After the briefing, however, Rep. Melvin Price (D-Ill.), subcommittee chairman, said that a "new type" aircraft with a long fuselage and delta wing had been sighted in Russia. He added the plane appeared "suitable" for nuclear power but would not say whether intelligence reports indicated that nuclear engines already had been installed or used.

AVIATION WEEK in December said the Soviet nuclear aircraft, 195 ft. long and with a 78-ft. wingspan, had been seen both on the ground and in flight. Two conventional turbojet engines have been installed in wingtip pods and two direct air cycle nuclear powerplants in 36-ft.-long nacelles are about midway out on each wing.

Drawings and photographs of the aircraft which Air Force has used to conduct aerodynamic studies, are reportedly similar in detail to the artist's conception of the bomber which accompanied the AVIATION WEEK report.

Although confirming the existence of a new type Soviet plane, Price said that, based upon intelligence reports and on his own information, he thought it would be misleading to state categorically that Russia has flown an aircraft wholly on nuclear power.

"If the plane had actually flown under nuclear power," he said, "I wouldn't have to say so. They would announce it to the whole world. On the other hand, I personally think there is a good possibility that the Soviets are well down the road in their nuclear plane program and have the capability of producing a flying nuclear-powered aircraft in the near future."

It was pointed out in the AVIATION WEEK report that, although much of the early flight testing of the plane had been conducted on conventional power, the nuclear powerplants have been tested in the air.

Representative Price said that, in view of Russian progress in the nuclear-powered aircraft program, he believes the first flight under nuclear power will be made by the Russians sometime this year. The Soviet Union has announced that 1959 "will see the first trials" by the Russians of "atomic engines for civil aviation," (AW Jan. 12, p. 26).

In the announcement, Russia said its scientists have been working for some time on the problems of efficient use of atomic engines for civil aviation and the results obtained make it possible to state that 1959 will see the first trials of a civil aircraft in this field.

Representative Price took a more pessimistic view of the U.S. position than Defense Secretary Neil H. McElroy. At the time of the AVIATION WEEK report, Secretary McElroy said he was "highly skeptical" that the Russians had flight tested a nuclear plane but admitted that they might have a "slight lead" over the U.S.

Price on the other hand, declared the Russians are from three to five years ahead of the U.S. in this field and that it will be even farther ahead unless the U.S. presses forward with its own program. AVIATION WEEK estimated that the U.S. is at least four years behind Russia in this area (AW Dec. 1, p. 21).

The difference in progress between the U.S. and Russian programs, Price said, is largely a matter of attitude. The Soviets he said adopted a high priority program back through about eight years of research and development. Conduct of the U.S. nuclear aircraft program, Price said, has been characterized by indecision and lack of affirmative leadership. He added that statements made by Administration officials to the effect that development of an early flying nuclear plane would have little or no utility and would delay achievement of a high performance military plane "are smoke screens for inaction and without basis in fact."

Statements such as these are misleading, Price said, since they do not stress the importance and necessity of achieving flight experience with nuclear engines. In addition, he added the committee has received considerable testimony from responsible military representatives as to the military uses for nuclear powered aircraft. These missions include use as roving intermediate range ballistic missile carriers and anti-submarine patrol craft.

Price, long an advocate of early nuclear powered flight also expressed concern over the reported slash in funds for the ANP program in the Fiscal 1960 budget. "It represents a serious blow to the prospects of our aircraft nuclear propulsion project," he said, "and is further evidence of the Administration's do-nothing attitude in this vital field of scientific research." He added:

"I think that in terms of our national security and U.S. scientific prestige throughout the world, we must abandon the present policy of drift and indecision and get on with the job."

Price added that, despite assurances by Defense representatives to the committee last year, no concrete objectives have been established for the program.

Convair Gets Space Contract

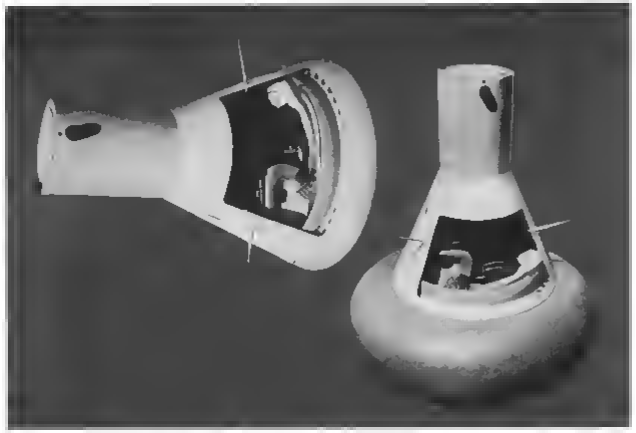
Washington—Contract to develop and build a 40,000-to-50,000 lb. second stage for the Atlas intercontinental ballistic missile was assigned to the Convair Division of General Dynamics Corp. last week by Air Force's Air Research and Development Command. Contract was let under authorization granted by Defense Department's Advanced Research Projects Agency.

The second stage will enable the Atlas to put payloads of 8,000 to 10,000 lb. into orbit with a 300 mi. perigee. Powerplant for the new Atlas stage is being developed by the Pratt & Whitney Aircraft Division of the United Aircraft Corp. under ARDC contract (AW Nov. 10, p. 26). Propellants under consideration for the Pratt & Whitney engine include liquid hydrogen and fluorine. Designation for complete second stage with engine is "Centaur" (AW Dec. 15, p. 23).

First year value of the Convair contract was announced as $7 million and its total at about $35 million, which probably will cover about half of the projected development work.

Krafft A. Ehricke, Convair space and missile expert, has been placed in charge of Convair's development of the second stage.

Only modifications to the basic Atlas missile that will be required to accommodate the high energy second stage will center around the nose structure. Major portion of the Atlas body is a thin pressurized structure that has proven in flight tests to be stronger than originally predicted.



NASA capsule model in launch attitude (left) shows boom and abort retrorocket package mounted on nose. Man rides backwards in flight attitude (center). Landing bag is inflated for landing (right). Beryllium heat sink is on large end of capsule (AW Nov. 24, p. 28).

McDonnell Wins NASA Capsule Award

T. KEITH GLENNAN (left), NASA administrator, and James S. McDonnell, McDonnell president, discuss model.

Washington—McDonnell Aircraft Corp. last week was chosen by National Aeronautics and Space Administration to build a dozen or more satellite capsules to put man into orbit around the earth (AW Nov. 24, p. 28).

McDonnell was selected over 11 other companies. Negotiated contract will call for a cost in excess of $15 million for the capsules and its subsystems.

Collins Radio Co. has been named by McDonnell as subcontractor for the complete electronic instrumentation system. Minneapolis-Honeywell's Aeronautical Division, has been chosen to develop the stabilizing and control system.

Design and construction of the capsule, which will weigh between 2,000 and 3,000 lb., is expected to take at least three years.

Over-all program, including launching and tracking, is designated Project Mercury. The capsule will be launched by a Convair Atlas-D missile booster and guided into an almost circular orbit between 100 and 150 mi. to permit a 24-hr. orbiting period.

Competition for the capsule award, although it is small in dollar volume by comparison with many current weapon system contracts, was intense because of the prestige involved.

Capsule will be a high-drag, no-lift shape with a blunt re-entry face. Pilot will have the option of altitude control and decision as to when to re-enter. Re-entry also will be controlled from the ground.

Pilot will face rearward from the time he goes into orbit until he returns to earth. Landing can be in water or on land, but probably will be in water. He will have a viewing port at his feet, periscopes and an instrument panel.

Collins systems will include:

- **Two-way voice radio communications.**
- **Radio command system** for control of the capsule.
- **Telemetry system to send back** capsule conditions, medical observations and scientific information. Some data will be recorded in flight and telemetered over stations.
- **Guidance system to assist** in putting the capsule into orbit and assist in guiding it back to earth. This apparently is not the missile guidance system but a complementary one.
- **Rescue radio beacon system** for locating the capsule after it lands.

Minneapolis-Honeywell's systems will control a series of small reaction jets to keep the capsule from tumbling and to orient it properly before and during re-entry.

It also will automatically eject the capsule from the missile and automatically control its safety features in case of a malfunction during launch. It will fire the retrorockets that will cause descent.

Ground testing, development, qualification flight testing and pilot training will precede the first manned orbital flight.

Sparrow III Details Outlined by Navy

Washington—Navy last week formally unveiled its newest all-weather air-to-air guided missile, the Sparrow III developed by the Raytheon Manufacturing Co.

The new missile employs a semi-active radar guidance system which homes on radar impulses transmitted from the launching aircraft and reflected from the target. This guidance system allows the Sparrow III to attack targets from any direction and from any side angle as well as targets that are thousands of feet above or below the launching aircraft.

Such a capability is a distinct improvement over older U. S. air-to-air guided missiles, some of which cannot be used unless the launching aircraft is aft of the target or in a restricted position to the side.

The older missiles also placed a greater demand on the pilot for skill in maneuvering his aircraft. The pilot in many instances, had to fly a definite and precise course after launching the missile so that the beam rider guidance system could steer the missile into the target. With the Sparrow III, the pilot does not have to aim his aircraft at the target during any part of the interception.

He also can fly a random course employing evasive maneuvers after launching the missile.

Equipment in the Sparrow III includes a small computer to control the missile so long as it receives the reflected radar energy from the target. The accuracy of this guidance system then improves as it nears the target.

Sparrow III will not use a nuclear warhead in the near future, according to the Navy. Main reason probably is its short range listed as approximately five miles. This range however varies considerably, depending upon the target's course relative to the launching aircraft.

The missile carries about 50% more conventional high explosive than other U. S. air-to-air guided missiles. Quite large it is carried externally on Navy aircraft in contrast to the usual Air Force preference for internal stowage. Missile is about 12 ft. long with an external diameter of 8 in. It weighs about 350 lb.

Sparrow III has entered operational service with several Navy squadrons, some of which are stationed on the carriers Midway and Bon Homme Richard.

Only Navy fighter presently equipped to launch the Sparrow III is the McDonnell F3H-2.

The new McDonnell F4H-1 Mach 2-plus fighter just ordered into quantity production by the Navy also will carry the Sparrow III. The F4H-1 is scheduled to be phased into service in 1961.

USAF Wizard Contract

Washington—Theoretical studies and restricted experimental work on interception systems for intercontinental ballistic missiles originally begun under the Air Force Wizard program are being continued by the Defense Department's Advanced Research Projects Agency.

ARPA authorized two contracts totaling more than $25 million with the Convair Division of General Dynamics Corp.—one through USAF's Air Research and Development Command for theoretical and limited experimental studies of various kinds of ballistic missile defense systems, the other for basic research into the various phenomena involved in the operation of ballistic missile systems and defenses against them.

The second contract, for basic research type studies, will not be made final until Convair has conferred with scientists from Air Force's Cambridge, Mass., research center and the Army Rocket and Guided Missile Agency at Huntsville, Ala. After agreement has been reached in these consultations the contract will be submitted to ARPA for approval. The two service agencies will then be responsible for the detailed administration and technical direction of the contract, and ARPA will provide broad policy and technical guidance.

The work at Convair will be under the direction of I. M. Pasternak, who has directed the Air Force-Convair Wizard anti-ICBM studies for approximately four years.

There apparently will be no change in Army's Zeus ICBM detection development program.

Symington Scores Budget Utilization

Washington—Administration's failure to utilize the $1.3 billion Congress appropriated beyond that asked by President for defense during fiscal 1959 came under sharp criticism last week on the Senate floor from Sen. Stuart Symington (D.-Mo.).

Symington, aided by Sen. Dennis Chavez (D.-N.M.), chairman of the Senate Defense Appropriations Subcommittee gave this list:

- **Congress gave $90 million** additional to expedite work on the Air Force's Minuteman multi-purpose solid ballistic missile program. None of this has been used or is scheduled to be used during fiscal 1959, Symington said.
- **An additional $48 million** was appropriated for the North American Hound Dog air-to-ground missile for use with the Boeing B-52G intercontinental bomber. None of this has been used or is scheduled to be used this fiscal year.
- **An additional $55 million** was approved for more Boeing KC-135s. None of this money has been used.
- **Congress appropriated $140 million** for production of modern strategic airlift aircraft. No part of this has been used or is scheduled to be used.
- **An additional $609 million** was appropriated to expand Navy's Polaris fleet ballistic missile program to boost the number of submarine carriers from five to nine. Funds for one additional submarine have been allocated, but there is no plan to use the rest of the money.
- **Money appropriated by Congress** for the personnel strength of the Marine Corps was frozen, or used for other purposes not specified by Congress.

Polaris Development, Testing Accelerated

Washington—Development and test schedule of the Polaris fleet ballistic missile system is being pushed on a wide front by Navy and Lockheed's Missile Systems Division to meet the operational timetable established for this underwater-based retaliatory weapon.

Program calls for an extensive acceleration in test firings this year of missiles which substantially approximate the operational configuration which is scheduled to be available in late 1960. The test program this year may be accelerated to a firing frequency of one missile approximately every two or three weeks, to return an increasing mass of development test data which already is being accumulated on as many as 40 information channels from test missiles.

Meanwhile, work is being advanced on the George Washington, the first atomic-powered submarine designed to carry the Polaris. Scheduled to be commissioned in 1960, this first of a series of new type submarines with the capability of an IRBM underwater launch, will slide down the ways in about three or four months, then be fitted to perform its strategic job of underwater launch platform.

Missile Size

Before the Polaris reaches its operational status, underwater firing trials with full scale development models will be conducted with this submarine according to present planning. Size of the operational missile is approximately 26 ft. diameter will be between four and five feet. Sixteen of these weapons will be accommodated in a vertical position aboard the submarine.

A considerable number of alternate schemes have been evaluated to launch Polaris from the submarine. Plan now is to launch the missile unencapsulated, propelling it up out of the submarine using gas pressure as the expelling medium, with the missile igniting after it breaches the ocean surface and reaches an altitude of about 80 ft. It is probable that the missile will not necessarily have to clear the surface to fire, a technique which may be employed if the submarine is at a deep level.

Development testing and related activities for the Polaris are being conducted at sites on both East and West Coasts.

▪ **Cape Canaveral, Fla.** Latest firing from this test site, scheduled for late last week, was to be the 26th shot in the Polaris test program. Previous test firing on Dec. 30, initially was scheduled to go on Dec. 16, but short circuit in instrument wiring caused the shot to be held. The missile was taken back to its test hangar and fired again when the range was made available on Dec. 30. In this shot, stage separation was achieved and the second stage ignited. Considerable gyration was experienced with the missile when it flew off course, and substantial readings were obtained relating to the structural integrity of the airframe.

Before this, an attempted launching failed when the second stage ignited prematurely on the pad, lifted off a few hundred feet and was destroyed, with first stage still on the pad.

The firing on Sept. 24 initiated the AX series of Polaris test vehicles, representing the most advanced test configuration to date. AX series will be continued through most of this year, be followed by still another series, the AX-1, before an actual Polaris is fired. The AX vehicle is an almost exact approximation of the external appearance of the ultimate Polaris configuration and uses an Aerojet-General powerplant. An electrical programmer, rather than an operational guidance system, is used to tip over the missile after the first few seconds of flight in order to head the vehicle out to sea. In the Sept. 24 firing, the missile received this signal from the programmer it carried but failed to respond, continued to fly vertically and had to be destroyed. Destruction, however, was not complete—one piece of the missile fell into the water near the Cape while a second piece landed in the Banana River about six miles from the launch pad. On the basis of this experience, the destruct system has been modified and relocated to ensure the destruction of the entire vehicle following a destruct signal.

Before this first firing of the AX series, test vehicles used for the most part were powered by Thiokol rockets and were employed to check out systems and components and such factors as thrust termination and method of flight control. In addition, some modified Lockheed X-17 test vehicles were used to check the Polaris nose cone re-entry factors.

While most of the early test vehicles had similar front-end configurations, they did not approximate the external configuration of the ultimate Polaris missile.

Twenty-one successive successful firings extending over about a year and a half preceded the September shot.

Part of the test program will involve the USS Observation Island (EAG 154). This vessel, commissioned at Norfolk, Va., has been converted to perform substantially everything the Polaris submarine will do except submerge. Scheduled to arrive within the next two months at Cape Canaveral, where the harbor has been dredged to accommodate it, the Observation Island will be under operational control of a Navy ordnance test unit at the test site. The vessel, fitted with launch tube, will go to sea and fire the Polaris.

In the test program, the vessel will be an intermediate step between land and submarine firings, affording a more realistic operation than a firing from the land-based slup motion simulator now used at Canaveral. This land-based installation is contained in a 55-ft. pit, has a hydraulically operated mechanism which imparts pitch, roll and heave through tape-controlled programming. A launch tube which simulates the submarine installation is located in the center of the shaker.

Dummy missiles only have been fired, but live shots are expected to be programmed from this land-based installation within a matter of months.

▪ **Hunters Point, Calif.** This facility near San Francisco is the site of Operation Pea Shooter. Here, a full-scale development model of the launching apparatus has been under test since early last year. This is a static installation set at an angle of 85 deg. Initially, red wood logs cut to the diameter of the launch cylinder were fired, then recovered as they floated in the bay.

These have been followed by concrete filled steel dummy missiles which have the same size, weight and center of gravity location as the projected Polaris missile. A boat crew with crane recovers the dummy missile, which is prevented from sinking by flotation gear. Operation Pea Shooter probably will progress to include structural tests.

▪ **San Clemente Island.** This facility located off the California coast is the site of Operation Pop Up, which uses an underwater launch technique. Dummy missiles are used. These are loaded into launch tubes at Navy's Long Beach facility and towed to the San Clemente site. Enclosed in an outer housing, the tube is sunk to the ocean bottom where it is fixed to a concrete pad under the control of Navy frogmen. In addition to instrumentation, underwater cameras also are part of the elaborate and precise installation. In its upward path after it is launched from the underwater pad, the dummy missile triggers a net which closes over the launcher to protect it as the dummy sinks back into the water. The net also facilitates retrieving of the dummy missile (AW Aug. 25, p. 51).

▪ **Lockheed Missile Systems Division,** Sunnyvale, Calif., operates a test tank for small-scale simulation of underwater launch. The installation incorporates instrumentation and automatic cameras for viewing on three axes to provide data as to what happens to the missile model after it leaves the launch tube. Several hundred simulated firing tests already have been conducted in the facility, which is concerned with determining the hydrodynamic properties of the missile design. The tank incorporates a wave generator which can create, in scale, the equivalent of a hurricane force sea. One end of the tank has an inclined plane and baffle installation to prevent a sloshing effect in order to simulate open water realism.

Lockheed's Missile Systems Division at Sunnyvale also builds the vehicles used in the test program at Canaveral, where Lockheed operates the Polaris test facility for the Navy. Test vehicles are assembled at Sunnyvale with dummy engines and systems in the test missile are checked out. The missile is then disassembled for shipment by air from nearby Moffett Field to Cape Canaveral. Engines are flown from Aerojet's Sacramento facility to Canaveral, where the missile is assembled with the operating engines. The test vehicle is checked out again, and a trailer-erector hauls it to the launch pad located about 1 mile from the assembly hangar. Another check is conducted on the launch pad.

Although the operational configuration of the Polaris fleet ballistic missile is frozen with respect to its dimensions, the design anticipated the state of the art with respect to propellant specific impulse, warhead size and inertial guidance, which is similar to other developments of this type but much smaller and specifically tailored for Polaris service. Guidance system, developed by Dr. Stark Draper, of Massachusetts Institute of Technology, who also designed the SINS submarine navigation unit, is designated Q-Matrix.

Before the Polaris guidance is used in test flights, the equipment will be carried aloft in the test missile for environmental trials. Functioning, but not controlling the flight, the equipment will be instrumented to determine just how it responds in the operational environment.

Polaris support equipment will include devices that will continuously draw the existing position from the shipboard navigation system, recalculate the missile guidance program and set it into the guidance systems of all the missiles. A feedback loop will continuously draw the guidance program from each missile guidance system, backtrack through all the calculations and compare the input data with the output data. If a discrepancy develops, an interlock will open to prevent launch, and an indicator will alert the crew to the fact. They will then have to track down the source of the trouble, which could be in one or more missiles, in the check out gear or in the shipboard navigation system.

Navy doesn't plan to rely upon shipboard inertial navigation alone for existing position data. It will have several navigation techniques to use. Computer technique will allow the ship's navigator to weigh the results put out by the various systems and decide which is most accurate.

Five of the atomic-powered submarines to accommodate Polaris already are under construction. Four more are projected and will constitute a slightly different class in size and tonnage.

Voltigeur Crashes

Paris—Sud Aviation twin turboprop liaison aircraft, the Voltigeur, crashed shortly after takeoff killing a three man crew, including Roger Carpentier, a top French test pilot.

The accident happened several minutes after the aircraft took off from Istres French Air Force Test Center. Carpentier was at the controls. Witnesses said there was an explosion though no official verdict has been handed down.

Voltigeur recently flew for the first time with two Turbomeca Bastan turboprops, which develop about 750 eshp each. Early in 1958 the engine received ICAO certification after a 150 hr. bench test. Bastan reportedly has about 75 actual flight hours, including 45 hr. on the converted Beech 18 flying test bed (AW Dec. 8, p. 112).

Sud won a development contract for its Voltigeur, beating out a Dassault 415 liaison aircraft also powered by two Bastans (AW Jan. 12, p. 34).

F-89J Armed With Genie and Falcons

USAF Northrop F-89J armament consists of two Douglas MA-1 Genies, test versions of the MB-1 nuclear-armed Genie aerial rocket, and four Hughes GAR-2 Falcon guided missiles. Falcon between pylons under starboard side of wing is barely discernible, only one Falcon is visible under port wing. This is first photo of Genie that Defense Department has released although external configuration has been declassified for about a year. F-89 fired Genie in gunnery meet at Tyndall AFB (AW Nov. 10, p. 30).

Dassault Mirage IIIA interceptor is equipped with SEPR 841 rocket booster (first flight photo of the installation shows housing under fuselage) that provides 3,700 lb extra thrust and is ejectable in flight. Unit can be replaced with an auxiliary fuel tank having a similar configuration. Strake under nose section is an aerial. Aircraft is powered by Snecma Atar 9 turbojet developing 13,000 lb thrust.

First Photos of Mirage Rocket Engine, Inlet Spikes

Delta wing Mirage has flown at Mach 2 at 55,000 ft. without using its rocket booster. Engine intake geometry (above) includes inlet spikes. Aircraft recently climbed to 60,000 ft. at Mach 1.7 carrying Nord 5103 air-to-air missile. French Air Force has ordered 100 Mirages, production rate of nine per month is scheduled for July 1961. Conical camber is visible on wing leading edge.

Gen. Irvine Warns On Price Figures

Palm Springs, Calif.—Call to the aircraft industry for team effort to be carried out in good faith was issued by USAF Gen. C. S. Irvine at the Air Force-Aircraft Industry Conference on teamwork conducted here last week by Directorate of Flight Safety Research.

Irvine reported that "over the past several months post audits of contracts have pointed up some serious discrepancies between actual costs which were current at the time of contract negotiation and the prices submitted with the bids. Whether these differences resulted from honest mistakes or from expected price increases is not important. The fact that the discrepancies were neither explained nor corrected makes them suspect.

"As an outgrowth of this matter, the Air Force is now requiring industry to certify in writing that the quoted prices are actual costs. This certificate set forth in procurement instructions and supplemented by correspondence from Air Materiel Command must accompany proposals at the time they are submitted to Air Force.

"This problem is serious and immediate. While there is no implication that fraud or deliberate malpractice is taking place, there is sufficient evidence of 'errors' in this connection to warrant corrections now. If overpricing continues, the Air Force may find it necessary to conduct pre-audits of proposals," he added.

The general told industry leaders that they are expected to plow back into the national research program a portion of their profits since the knowledge gained will result in more business for them.

Regarding the advantages and disadvantages of selling to the military, he said, "I understand from some sources that certain aircraft industry spokesmen claim profits from government contracts are lower than from commercial sales. I believe on the basis of similar computations where commercial profits are reduced by the amount industry turns back to self-improvement or product research, the net profits from both types of contracts will be comparable. Add to this the fact that most Air Force contracts stretch over a longer period, providing an extra degree of stability, and the Air Force contract may appear to be an even better venture."

Gen. Irvine called for greater use of off-the-shelf components and asked industry not to "reinvent" what has already been invented for another application. In some new missiles and support equipment entire subsystems should be borrowed "as is." He conceded that proprietary rights should be honored but said they should never be allowed to stand in the way of an accelerated program.

He said that weapon system testing poses major problems other than the technical ones. "When a test phase comes too early in the total program and an unreasonable number of firing failures occur, the program will usually slip. In addition, national prestige takes a beating. Now, I am not asking that tests be held off until 100% reliability is absolutely assured. But I am urging producers to recognize the full significance of a test program and to take whatever actions are necessary to assure maximum success from the outset. Since public opinion is directly affected by the test programs, and since Air Force appropriations approved by Congress are a reflection of this public opinion, it behooves both the Air Force and industry to face up to the pressures imposed by highly publicized tests. Failures must be kept to a minimum."

Titan Base Contracts

Los Angeles—Plans are well under way for first Martin Titan intercontinental ballistic missile operational launch sites, according to Maj. Gen. Bernard A. Schriever, commander of the Air Force Ballistic Missile Division. First installation will be at Lowry AFB, Denver.

Contract for design of Titan bases has been awarded to a team composed of Daniel, Mann, Johnson & Mendenhall & Associates, Los Angeles; The Rust Engineering, Pittsburgh, Pa.; Lea Daly Co., Omaha, Neb.; and mason and hangar—Silas Mason Co., Inc., New York.

Already under construction at Vandenberg AFB in Lompoc, Calif., is Titan operational system test facility which will provide the only full scale testing capability for the complete weapon system.

Program Announced For Flight Congress

Washington—First World Congress of Flight, being held in Las Vegas, Nev., April 12-19 under the Air Force Assn., will feature three major conferences dealing with the "Jet Age, Space Age" and "Missile Management."

To date, 88 companies have ordered space to exhibit at the outdoor and indoor display areas of the congress, according to Edward P. Curtis, general chairman of the event. Curtis, former presidential assistant on aviation, is now executive vice president of Eastman Kodak Co. Foreign firms exhibiting include Rolls Royce Ltd. and the Hawker Siddeley Group of Great Britain and the Societe Nouvelle des Aeronautiques of France.

Here's the tentative program for the congress:

- **April 13**—Jet Age Conference, jet liner demonstrations.
- **April 14**—Jet Age Conference, general aviation air ground demonstrations.
- **April 15**—All day military demonstrations. Tenth NATO Anniversary Program.
- **April 16**—Missile Management Conference.
- **April 17**—Space Age Conference; congress banquet.
- **April 18**—Air demonstrations.
- **April 19**—Air demonstrations.

News Digest

Boeing Airplane Co. will reduce employment at Seattle and Renton, Wash., by about 1,500 persons with most layoffs hitting the Transport Division at Renton. Fred Hulcen, personnel director, noted that Boeing 707s and KC-135s are past early production stages when employment reaches a peak.

German Defense Ministry expects to sign a contract for procurement of Lockheed F-104 Starfighters by Mar. 1 (AW Nov. 10, p. 33). Germans now will reportedly buy 15-20 second generation two-seater F-104Ds off the shelf plus another 20-40 all-weather fighters, leaning 250 or less all-weather F-104s to be built under license in Germany.

Fairey Aviation Co. is testing a new tip jet sound suppressor for its Fairey Rotodyne VTOL transport helicopter blades. Thrust and drag features of the new device still have to be determined, but the suppressor has shown a sound reduction of 13 db. as compared with the four decibel reduction attained with use of the present star-type suppressor. Rotodyne currently is continuing flight test program with open jets.

North Central Airlines has completed a $4.3 million financing program for purchase of five Convair 340s and to strengthen working capital. Civil Aeronautics Board has approved government guarantee of 90% of the $2,340,000 loan which will cover Convair purchases.

Propeller Division of Curtiss-Wright Corp. has been awarded a $5 million contract by Wright Air Development Center for first phase of a program to develop an all-mechanical flight control system capable of operating at temperatures from −100F to 1,000F.

Boeing 707-420 intercontinental jet transport last week made its first flight at Renton, Wash., and will be delivered to Pan American World Airlines later this year.

Airlines May Face Atlantic Fare Battle

Disagreement among IATA members on jet surcharge could lead to open-rate crisis and price-cut war.

By L. L. Doty

Washington—An open-rate crisis on North Atlantic routes appears likely despite guarded optimism that a compromise solution to the jet surcharge controversy will be reached by international air carriers next month in Paris.

Unless unanimous agreement is reached by both the airlines and their governments on a set of fares before March 31, the date current fares expire, the industry will become embroiled in an open-rate situation that could degenerate into a chaotic price-cut war. International Air Transport Assn's traffic conference broke down last fall in disagreement over the surcharge issue at a meeting in Cannes (AW Oct 27, p 26) where it convened to establish a 1959 rate schedule.

The reconvened conference, now scheduled for Feb 16 in Paris (AW Dec 29, p 34), is expected to eventually resolve the surcharge conflict but not without further wrangling on the subject. Full conciliation among the carriers has not yet been reached despite the fact that a number of private, out-of conference attempts to find a compromise level have been made during the past two months.

As a result Paris conference sessions probably will run well into March before a solution is reached. Since fares adopted by the conference must be approved by the governments before they become effective there is a strong possibility that final approval of the rates will come only after the March 31 deadline has been passed.

Open-Rate Possibility

This would create a temporary open rate situation—a hiatus that conceivably could give proponents of a jet surcharge the opportunity to make downward adjustments of first class fares on piston engine aircraft as a means of creating a fare differential. A definite open rate situation will evolve if the recommend traffic conference fails to make any agreement on the issue.

In the latter event, the individual governments will take over all negotiations on fare matters, a possibility industry views as a serious threat to the present system of equitable fare construction. International carriers are virtually unanimous in the opinion that any weakening of the conference's authority, as it is now constituted, would dangerously undermine the orderly pattern of competition on international routes.

Meanwhile, international carriers are being forced to postpone publication of 1959 tariffs and to delay advertising and promotional campaigns keyed to coincide with the first spurts of heavy spring and summer transatlantic travel. For the first time in its history the industry is in the dark as to the rates it will charge and the sales pitch it will use in generating new European traffic.

Loss of the traffic conference mechanism as the result of an open-rate condition would be especially serious to U. S. carriers. At present, bargaining power of all members of the traffic conference is equal.

Since a unanimous vote is necessary for approval of any issue and since each member carrier is entitled to a single vote on all issues, each member, regardless of size or scope of operation holds the power of absolute veto.

U. S. Weakened Position

However, in an open-rate situation, such a voting system would no longer apply and rates would be worked out bilaterally between the carriers. This places U. S. carriers in a weakened position for three reasons:

- **U. S. government and airline industry are split over a legal interpretation** of exactly how much authority the U. S. possesses in international rate-making. The government contends that the U. S. has no authority to make international rates and, therefore, no authority to bargain with other countries on any terms that involve rates. The industry contends that such power is implicit in the Federal Aviation Act of 1958 and in the terms of the Chicago Convention.
- **State Department will represent the** U. S. in any fare negotiations resulting from an open-rate condition. Because of the government's position on rate making the U. S. will be forced to bow to any demands from foreign countries that, if a jet surcharge is not adopted, landing rights in those countries will be denied U. S. airlines. In 1951, Great Britain threatened to cancel Pan American's landing rights in London unless the carrier's proposal for low fares was lifted. In this instance, final agreement was reached within the traffic conference to introduce tourist rates on the North Atlantic after an open rate crisis had become a strong possibility.
- **Rift on the surcharge issue exists be**tween Trans World Airlines and Pan American. TWA supports the extra fare. Pan American is a leading opponent of the charge.

Possible Solution

Key to an early solution of the possible temporary open-rate situation is the Civil Aeronautics Board. Foreign air carriers voting in the traffic conference are in direct contact with and under instructions from their governments. Thus, it can be assumed that any fares agreed upon by the foreign carriers will be promptly approved by their governments without time-wasting delays.

However, in the case of the U. S. TWA and Pan American must first be in accord on the surcharge. Then, the fares agreed to must be filed with the Board for approval.

Despite pressure on the Board by the industry for some indication as to the type of fare structure it will approve, no action has yet been taken by the Board.

Consequently U. S. carriers have no way of knowing which fares will be acceptable to the Board. In effect, they are forced to vote blindly, not knowing whether they are taking an action that will receive the support of the U. S. government. Disapproval of fares adopted by the conference would force an open-rate condition on North Atlantic routes.

In 1957 Civil Aeronautics Board voted against a rate increase of 5% on North Atlantic routes after the traffic conference had unanimously agreed upon the fare adjustment. The decision by the Board threw the issue back in conference where a settlement was reached in sufficient time—well before the April 1 deadline—to avert an open rate problem for 1958.

Civil Aeronautics Board power in the field of international air transportation is limited to matters which are "unjustly discriminatory." In effect the Board's powers to regulate fares and rates is confined to domestic air routes. Nevertheless the Board has always felt obligated to control international rates under its theory of "regulated competition" and has resorted to the Anti-Trust Act as a means of achieving this.

U. S. carriers cannot enter any agreements legally with foreign-flag carriers without risking prosecution under anti-trust legislation unless the CAB finds that such agreement is not contrary to the public interest. Accordingly, if the Board disapproves any IATA resolution such as a fare adjustment adopted unanimously by the traffic conference and by all governments other than the U. S., American carriers are prevented from becoming parties to it by anti-trust laws. In such cases, of course, provisions requiring unanimous support of all governments on IATA issues are not met.

The Board's decision on IATA resolutions directly affects only U. S. airlines and those foreign-flag carriers operating into U. S. ports. However, these decisions often have far-reaching effects since North Atlantic fares are closely interwoven with fares on other routes due to joint and through rates.

Observers close to the fare problem are unwilling to make any firm predictions as to the outcome of the conflict but this is the general trend of thinking at the present time:

- **Every effort will be made** by delegates to the traffic conference in Paris to close the gap between the views and have votes in jet operations in hopes of preventing another stalemate and subsequent loss of power to the conference.
- **First-class, tourist and economy fares** will be hiked $5 and de luxe fares will be increased by $15 as first reported by Aviation Week (Oct 27, p 26).
- **Agreement will include** a slight surcharge—probably $10—on all fares covering jet flights over North Atlantic routes. American Airlines and National Airlines have filed tariffs with the CAB seeking a $10 surcharge on transcontinental and New York-Miami jet flights.

Failure of the traffic conference to arrive at a solution to the jet surcharge fight is not looked upon by the industry as a reflection on the delegates to the conference. The deadlock on jet fares is generally attributed by observers to pressure from governments seeking to protect the prestige of their carriers.

Governments tend to guard jealously their direct authority over air transport operations. Moves to create a supranational Civil Aeronautics Board-type agency to regulate all international air lines have always failed because of refusal by major governments to relinquish any of their sovereignty.

U. S. carriers have firmly resisted attempts to bring stronger governmental control over international operations and the issue will be investigated during the forthcoming House Commerce Committee's hearings on international air service (AW Jan 12, p 43).

The IATA traffic conference is actually a quasi-governmental agency which must operate in two areas. In one area, the conference is required to standardize rates, fares, rules, contracts, waybills, tickets and baggage checks according to the needs of the industry. In the other, the conference must satisfy the interests, customs and national laws of each country represented.

The conference is thus a "united nations" within the airline industry. It must combine the diplomatic processes of international relations with technical requirements of airline operation.

Delegates, who are trained experts in traffic matters, must adjust to the wide divergent interests of many nations and creeds in order to reach agreements that are binding only by unanimous consent, are essentially voluntary and subject to the close scrutiny of high level government officials.

Observers of the traffic conference in action are struck by the unusual harmony with which arguments on resolutions are conducted despite the many nationalities and special interests represented. Success of the conference in reaching compromised accord is evidenced by normal willingness of the governments to accept the decisions of their airline specialists. In the past 10 years less than 5% of more than 5,000 resolutions have been rejected by any government.

In effect, there are three traffic conferences—one for the Western hemisphere, another for Europe, Africa and the Middle East and a third for Asia and Australia. However, the three conferences meet as one in the same place and at the same time in order to coordinate the traffic problems of each.

The traffic conference is conducted by a chairman and a vice chairman who are elected annually from among the delegates who serve without pay. This year's chairman is Philip C. F. Lawton of British European Airways.

Each of the three conferences maintains subcommittees on agency matters. The conference also has joint working groups for costs, traffic, accountancy, restricted articles, reservations, cargo specific commodity rates and creative fares.

Convair 880 Makes Initial Taxi Tests

Initial taxi tests of Convair 880 jet transport are conducted at Lindbergh Field, San Diego, Calif. Taxi speeds varied from 40 to 80 mph. Acceleration, brakes, steering and lateral control during taxiing were tested. First flight is due at end of this month.

ELECTRA arrives at Idlewild on Eastern Air Lines' schedule

Eastern First to Operate Electra; Begins Service With Fleet of 12

New York—First scheduled Lockheed Electra service, delayed since Dec. 1 by a long strike shutdown, was inaugurated by Eastern Air Lines last week with schedules to nine cities. Two more points were to be added today for a total of 18 daily schedules and two four times a week flights. Fleet last week totaled 12 of the turboprops, with additional planes in the order of 40 to be delivered at the rate of about one a week.

With less fanfare than would have marked the earlier inaugural, Eastern's first regular scheduled Electra flight left Miami Jan. 12 for New York and Montreal with 20 paying passengers aboard. Two southbound flights out of Idlewild the same morning departed with 56 and 20 passengers respectively. In general, it was taking Eastern a while to gather new momentum after the 38-day interregnum.

First Schedule

The first schedule left Miami at 9:30 a.m., reached Idlewild in a flight time of 2 hr., 54 min., and a block time of 3 hr., 4 min. Scheduled New York-Miami time is 3 hr., 15 min., for the Electra. First flight lost an hour on the ground at Idlewild with generator trouble before proceeding to Montreal.

Ramp handling of the Electra operation requires little additional equipment except a start and electric power truck. There are two of these units at Idlewild. A truck supplies air to No. 4 and then No. 3 engines for starting, with about 45 lb. of pressure used for a start. Other engines are turned over by bleeding air from the running engines.

Eastern carries no air bottles on its Electras, so the only way to start their engines is with an external unit. Some stations are stocking portable start units which can be ferried to off-line points when and if necessary.

With the airplane's built-in electrical single-point fueling system, fueling time will average approximately 10 min. less than the 25 min. required to put 5,000 gal. in a Douglas DC-7B, Idlewild's station manager J. N. Mitchell estimates. First scheduled flight carried 25,000 lb. of fuel used about 16,000 lb. at 15,000 ft. against a 10-mi. headwind. Most practical altitude for New York-Miami Electra runs is about 15,000, because this is the most available altitude from an air traffic control standpoint. Ideally, altitude would be chosen in relation to wind and temperature.

Carrier's turboprop schedules are all first class, with 66 seats plus four saleable lounge seats. When some of the planes are converted to coach configuration, they will seat 91 passengers. No date has been set for Electra coach service, however, and it may not come until Eastern's Douglas DC-8 jets are in service.

As of today, New York, Montreal, Miami, Tampa, San Antonio, Detroit, Chicago, Washington and Newark are being served by Electras. In addition, the planes are stopping at Cleveland and Atlanta in one direction only.

Avro 748 Turboprop

London—Hawker Siddeley is developing a Douglas DC-3 replacement called Avro 748, in a new privately financed venture, Hawker Siddeley Managing Director Sir Roy Dobson announced.

Avro 748 will be a short-to-medium range turboprop airliner to carry 36-44 passengers. It will be full-pressurized and powered by twin Rolls-Royce Dart engines, he said.

Some $6 million is believed to have been allocated initially for the project, on which there's already been some preliminary work. Company aims to get the aircraft into flight early next year.

Jet Finance Program Completed by Delta

Atlanta—Delta Air Lines last week completed a financing program calling for loans totaling $60 million to cover the purchase of six Douglas DC-8 and 10 Convair 880 turbojet transports.

Loans amounting to $35 million will be handled by 24 banks headed by Citizens and Southern National Bank of Atlanta under a revolving credit arrangement through which funds will be available to Delta until May, 1960. Repayment will be made over a period of seven years following the effective date of the loan.

Four life insurance companies—Prudential, Connecticut General, Connecticut Mutual and Mutual Insurance of New York—are underwriting loans totaling $25 million. Loans will be available in 1959 and 1960. Repayments will begin in 1968 and are due in 1974.

Delta will receive the first of its DC-8s in June and will begin service Oct. 1. Delivery of the first of the 880s is scheduled for January, 1960.

Northwest Reports Record Profit in 1958

Washington—Northwest Orient Airlines earned a net profit of $5.5 million last year on record operating revenues of $101.2 million for the highest earnings in the company's 32 years.

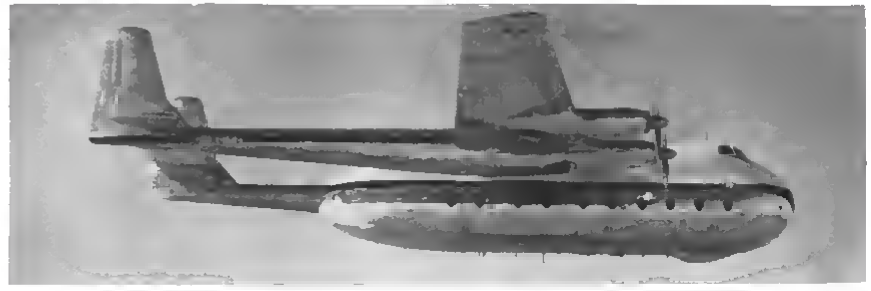
The year-end figure, based on 11 months of actual operations and one month estimated, was 21.4% above the 1957 operating revenues of $83.4 million reflecting records of 21.5% in passenger revenues and 14.1% in net income over the last year.

Passenger revenues for the carrier totaled $81 million during 1958, with income realized before interest, taxes and property disposals totaling $11.7 million for a gain of 127.8% over the previous year.

Operating expenses including depreciation costs, amounted to $90.7 million as compared with $78.4 million last year for a 15.5% gain over 1957.

Based upon Civil Aeronautics Board figures for the first 11 months of 1958, Northwest also led all domestic trunk carriers in the percentage increase in revenue passenger miles flown over the same period of 1957. With 1,003,782,000 revenue passenger miles flown last year, the carrier realized a gain of 15.4% in this category over 1957.

Crediting the company's record year to an intensified sales program coupled with a low cost operational program and the exclusive use of four-engine equipment, Northwest said its earnings per common share of stock increased from $3.56 in 1957 to $3.98 last year.



AW 650 Argosy Makes First Flight

First flight of Armstrong Whitworth Argosy 650 turboprop freighter was conducted successfully from Bitteswell, England, airfield. Argosy made its initial takeoff in less than 700 yd., flew for 62 min. Taxi tests have been limited because of severe snow conditions.

PacAero Engineering to Convert Hawaiian Convairs to Turboprops

Santa Monica—Contract for installation of Allison 501-D13 turbine engines and Aeroproducts 606 propellers in five Convair 340 transports for Hawaiian Airlines has kicked off what may prove extensive program of modification of the twin-engine Convair Liner to carry these powerplants, at PacAero Engineering Corp. here.

Hawaiian, which also had been negotiating for installation of Napier Eland turboprop engines in Convairs (see p. 67), seeks a delivery date as close to next August as possible. Convairs with Allisons will require empennage changes and new nacelles.

Also involved in the program, AVIATION WEEK has learned, is the possible modification of between 50 and 60 USAF C-131 transports. USAF Convairs include 240s (T-29 and C-131A), 340s (C-131B) 340 with turboprops (YC-131C), and 440s (C-131D).

Other federal agencies such as FAA also are understood to be interested in the conversion of Convairs to turbines.

Under the present agreement, Allison is handling sales of the combination, while PacAero will engineer the installation, handle certification programs, crew training and checkouts, and the production program. Gordon Israel, PacAero chief engineer, will be responsible for design of the modifications.

Allison, which is pushing hard to secure a foothold in the commercial airliner market, reportedly has given excellent guarantees on its power packages, which are used in Lockheed's Electra transport (AW Dec. 1, p. 52). Currently, the program embraces the 340 and 440 models of Convair Liner, these being substantially the same airframe, while the 240 is not contemplated for this modification at present although it may figure in later.

General prices on the modifications will run between $475,000 and $525,000 per airplane, according to the number of airplanes involved. In this, the customer furnishes the airplane, which is the basis of the agreement with Hawaiian Airlines.

Detail engineering is expected to be completed by June 1, with first flight of production hardware close behind. Target date for certification is in September for PacAero, which currently is operating one of the two USAF YC-131C airplanes in a flight test program.

In the present flight program, data being gathered will apply so far as possible toward CAA certification. However, on the production airplane, design differences will significantly affect various parts of the flight envelope will require flight test on the actual production plane.

USAF airplane being used is the same one on which Allison ran "Operation Hourglass," the Allison 1,000 hr. test of Electra power packages, with flights averaging on the order of an hour each. Altitudes varied widely and different fuels from 80/91 octane gasoline to JP-4 and kerosene were used.

This airplane had a empennage modified according to the 3,750 eshp power plants, resulting in 12 in. height being added to vertical stabilizer, 20 in. added to horizontal stabilizer span on each side (total 40 in. span increase), addition of 12 sq. ft. to the rudder and 17 sq. ft. to elevator areas.

Engineering on empennage was accomplished by Convair San Diego and PacAero is using these drawings as a basis of its production work. Changes will be made primarily as required by flight test results, otherwise will remain unchanged.

In the nacelles the YC-131C conversion was not engineered to the fine details, was primarily a cut-and-fit installation of the powerplants.

In the PacAero program, complete nacelle redesign will be accomplished for engine efficiency, ease of maintenance and engine change. Power packages will be quick engine change (QEC) unit as used on Lockheed's Electra (AW Dec. 29, p. 36).

Airplane in Operation Hourglass racked up fuel consumption average in the program—which was carried out in 84 calendar days—of 157 gal./hr./eng., including all the fuels and mixtures of fuels used. Rule of thumb on consumption used presently for Convair-Allison combination is for a 50,000 lb. gross weight takeoff, consumption of 400 gal. per hour 300 gal. per hour for remaining hours of flight. This is total fuel consumption rather than per/engine figures.

Cruising speed will approximate 342 mph. at 20,000 ft. at 48,000 lb. gross weight, for production airplane, cruise power (847C turbine inlet temperature).

Maximum takeoff gross weight for the airplane is 53,200 lb., with maximum landing weight at 50,670 lb.

PacAero also has contract to modify Convair transports 340 and 440, to use Napier Eland powerplants. Under the agreement, PacAero modified a 440 and installed the powerplants conducted the successful certification program on the 440 and a 340 which had been modified earlier by installation of the Eland powerplant.

Under the contract with D. Napier & Sons Ltd., PacAero was to accomplish this work and also modify three 340s for a South American airline. However, since then, Canadair, Ltd. has announced it will build 440 with Eland combinations as Canadair 540.

American Lists Third Pilot Duties

By Glenn Garrison

New York—American Airlines will operate its jet aircraft under "a new and fundamentally different concept of the division of duties in the cockpit" the carrier said last week after settling with its striking pilots.

Airline's "new concept"—i.e., need for another crewman, is sharply at variance with the expressed views of the two U.S. airlines currently operating jet aircraft. Neither Pan American World Airways, operating Boeing 707-120s on its North Atlantic route, nor National Airlines, flying New York-Miami service with leased PanAm jets, sees a need for adding to the cockpit complement.

America's new concept which it said was decided on last Dec. 1, involves a third pilot to handle air-ground communications and in-flight paper work and to provide a measure of relief to other crew members. Jet aircraft, according to the airline's new viewpoint, call for greater precision in matters of navigation, radio communication and radar operation. Because of the jet's speed, there is less en route time to perform routine cockpit operations so a fourth man is needed in the jet cockpit, officials said.

Recommendations

American said it reached this conclusion as a result of recommendations of supervisory pilots who had then flown more than 300 hr. in the airline's first Boeing 707-120 delivered last Oct. 23.

Radio contacts between the jet traffic controllers and company radio facilities, along with the paper work involved in keeping in-flight logs, amount to a full time job American said. It pointed out that a New York-Los Angeles nonstop flight of 2,451 mi. required a minimum of 81 radio contacts, each lasting about 50 sec. Shorter route segments present a proportionately more acute problem according to the airline. Between New York and San Francisco via Chicago, contacts were totaled at 101.

More Time

On the New York-Chicago route, American's Lockheed Electra crews actually will have about a half hour more time—without benefit of an extra crewman—to handle their contacts and paper work than will its 707-120 crews with their third pilots. Eastbound flying time for the Electra on the run will be about 2 hr. the 707-120 will make it in 1¼ hr.

National Airlines vice president-operations L. W. Dymond told AVIATION WEEK that his airline had found no need for an additional crew member in its New York-Miami jet operation inaugurated Dec. 10. National's answer to the communications problem has been to cut out about two-thirds of its geographical reporting points along the route. Speed of the jet reduces the time between points and therefore proportionately fewer points are needed to keep the airline advised of the plane's position.

Estimates of time over check points, Dymond said have been consistently accurate within 30 sec. during the jet operation to date. When National gets authorization to use a high-altitude airway on the route, such contacts can be reduced even further.

PanAm's situation is, of course, different in that there are fewer communications on a long overwater haul, and the airline carries a third pilot on navigational duty. But on a short haul such as New York-San Juan, PanAm says two pilots will be plenty.

Full Operation

American was back in full operation last week after reaching agreement with Air Line Pilots Assn. and ending a strike which began Dec. 19.

Solution of a major bargaining block was a pair of formulas governing pay and credit for duty time and for time away from home.

The details:

- **Piston and Electra** pilots will get flight pay and flight credit for a minimum of three hours in the first eight hours of scheduled duty time, whether flying or not. Duty time includes reporting an hour before a flight and 15 min. debriefing after it. Credit goes toward an 85-hr. monthly maximum flight time, and guaranteed minimums progress to six hours for over 12 hr. of on-duty time. Boeing 707-120 pilots will get three hours credit for the first four hours of duty time, and so on up to six hours' credit for 12 or more hours of duty time. For example, a jet pilot working 17 days with duty hours totaling 10-12 daily will be guaranteed minimum flying pay and credit of five hours a day, for a total of 85 hr., his limit for the month.

Formula represents an upgrading of previous formula under pilots' old contract.

- **Pay and credit for time away from home,** a new contract provision as far as American is concerned, amounts to one hour pay and credit for each scheduled four hours from leaving home base until return to home base. This provision, the airline says, may prove costly on short haul flights, where a pilot would fly for only a short time with a relatively long layover. Under the formula, a pilot away from home base 36 hr., for example, is guaranteed a minimum of 9 hr. flight pay and credit.

The new contract gives American's pilots a pay scale ranging from a base salary of $5,280 to a maximum captain's pay on the 120 of $28,448. Second year copilots will receive tops on a Convair of $8,117, DC-6, $9,131, DC-6B, $9,406, DC-7, $10,376, Electra, $10,936 and 120, $13,290. Maximum captain's pay starts at $17,891 on the Convair. These salaries are based on full 85 hr. month, half day and half night work. The third jet pilot, or second officer, will receive about $650 a month.

T-33-Viscount Crash Attributed to Jet Pilot

Washington—Emphasizing the importance of maintaining the "see and be seen" principle of flight safety, Civil Aeronautics Board last week ruled that a Maryland Air National Guard pilot was responsible for the midair collision last May 20 between a Lockheed T-33 jet trainer and a Capital Airlines Vickers Viscount turboprop transport (AW May 26, p. 25).

Failure of National Guard Capt. Julius R. McCoy to "exercise a proper and adequate vigilance to see and avoid other traffic" was cited by CAB as the probable cause of the accident over Brunswick, Md. which claimed the lives of all 11 persons aboard the airliner and a passenger in the jet trainer. Although severely burned, McCoy managed to parachute to safety.

The Board said that all evidence and testimony studied during the accident investigation indicated that the military plane overtook and banked into the Viscount as the airliner was descending while en route from Pittsburgh to Baltimore's Friendship Airport. The contention of military attorneys that operators of obsolescent radar equipment, which spotted the two planes from Washington National Airport but were unable to contact the Viscount and change the collison course of the two planes, contributed to the accident were rejected by the CAB on grounds that Capt. McCoy, from his overtaking position and in accordance with right of way rules in the Civil Air Regulations, was responsible for keeping a safe separation from the commercial aircraft.

"The Board believes that Capt. McCoy was not exercising the normal lookout for other aircraft required and expected of him," the official CAB accident report said. "Had he done so this accident might well have been avoided."

Airline Traffic—November, 1958

	Revenue Passengers	Revenue Passenger Miles (000)	Load Factor %	U S Mail	Express	Freight	Total Revenue Ton-Miles	% Revenue to Available Ton-Miles
DOMESTIC TRUNK								
American	625,663	415,402	69 2	1,790,619	914,523	7,945,120	50,545,144	68 1
Braniff	176,436	77,237	61 1	323,607	185,950	602,994	8,528,936	51 0
Capital	60,668	25,677	62 4	99,747	44,138	56,543	2,649,335	51 2
Continental	72,659	35,494	54 4	92,491	39,582	136,101	3,675,845	47 8
Delta	242,623	121,852	64 4	459,530	293,733	1,178,435	13,654,440	59 0
Eastern*								
National*								
Northeast	77,221	31,673	46 0	76,895	30,428	93,600	3,235,795	37 0
Northwest	136,087	90,940	58 2	531,542	256,396	1,077,136	10,588,337	50 7
Trans World	256,657	193,343	60 2	849,253	463,274	1,430,995	21,256,753	54 2
United	574,322	402,347	68 0	2,758,662	1,031,316	6,015,073	48,441,498	59 8
Western	108,194	54,321	53 5	236,257	79,849	318,527	5,841,646	45 8
INTERNATIONAL								
American	11,369	10,381	55 1	9,430	506	272,100	1,358,075	56 5
Braniff	3,708	7,200	47 7	14,962		100,357	903,400	43 9
Caribbean-Atlantic	19,059	1,321	60 3	1,496		4,290	144,793	65 8
Delta	3,751	4,109	43 1	7,515		35,412	502,040	38 5
Eastern*								
Mackey	6,104	1,286	42 1		147	1,537	140,284	41 9
National*								
Northwest	9,045	20,193	45 3	1,547,929	15,973	827,826	4,584,522	64 9
Pan American								
Alaska	1,900	2,093	32 3	27,095		173,250	428,821	42 9
Atlantic	73,852	102,907	62 8	1,691,739		2,608,169	15,146,511	68 1
Latin America	90,883	95,964	64 4	369,112		4,856,937	14,437,918	63 8
Pacific	21,407	84,841	70 9	1,370,958		2,833,347	12,672,502	70 0
Panagra	10,392	14,290	56 8	68,011		354,091	1,988,528	58 9
Resort						3,637,804	3,637,804	80 7
Trans-Caribbean*								
Trans World	18,130	57,420	69 9	701,717		1,479,653	8,107,256	70 5
UMCA	183	60	44 1			1,344	7,567	50 6
United	6,507	16,139	58 6	134,716		79,409	1,868,680	48 8
Western	2,122	3,300	62 9	1,794		9,770	369,767	65 8
LOCAL SERVICE								
Allegheny	41,005	8,010	56 8	14,612	22,290	23,278	884,939	57 8
Bonanza	14,010	3,359	44 2	5,170	2,295	7,483	336,739	42 5
Central	11,379	2,242	33 9	6,422	3,335	10,779	235,249	31 2
Frontier	17,043	4,567	42 3	15,898	7,883	62,420	525,331	51 1
Lake Central	16,261	2,729	42 7	3,132	16,466		280,646	46 4
Mohawk	40,450	8,002	58 1	8,033	14,971	17,647	883,022	58 3
North Central	60,025	9,896	46 4	26,462	40,452		1,810,380	47 4
Ozark	35,173	6,783	49 5	9,948	18,778	18,121	693,862	51 3
Pacific	32,111	7,209	51 6	9,223	4,352	5,881	706,779	49 4
Piedmont	35,480	7,634	56 6	11,192	13,902	13,612	769,849	57 1
Southern	19,027	3,627	43 6	9,461	10,562	9,847	377,477	42 8
Trans-Texas	20,634	4,785	42 1	13,568	9,777	28,181	510,554	43 1
West Coast	18,912	3,814	46 36	4,108	1,988	4,456	374,718	44 45
HAWAIIAN								
Hawaiian	29,007	4,316	51 5	4,310		113,410	469,598	53 1
Trans-Pacific	12,164	1,601	50 9	602		6,678	135,916	52 3
CARGO LINES								
AAXICO				13,303	20,841	3,065,250	3,099,194	73 1
Aerovias sud Americana						675,976	675,976	82 1
Flying Tiger	1,888	9,100	100 0	31,439	67,008	11,049,310	12,057,996	85 0
Riddle								
Domestic				34,828	52,563	4,427,779	4,515,170	87 6
Overseas						1,029,819	1,029,819	87 2
Seaboard & Western	394	1,697	100 0	119,966		1,609,359	1,904,621	48 0
Slick	2,987	20,122	99 74				2,012,256	99 74
HELICOPTER LINES								
Chicago Nallcopter	9,094	169	34 7	1,003			17,104	26 1
Los Angeles Airways	2,191	84 3	50 1	3,146	1,773		13,021	55 1
New York Airways	8,213	169	48 1	1,311	952	623	19 385	48 2
ALASKA LINES								
Alaska Airlines	5,754	3,104	37 8	61,227	2,755	196,479	582,468	37 2
Alaska Coastal	3,581	330	61 8	5,141		3,724	42,817	48 2
Cordova	578	96	29 0	4,363		31,414	45,778	49 0
Ellis*								
Northern Consolidated	1,205	381	39 8	24,405		40,320	107,689	63 1
Pacific Northern	7,223	6,590	42 4	101,513	6,091	292,871	1,114,558	57 0
Reeve Aleutian	949	993	42 5	43,442		97,002	248,395	44 8
Wien Alaska*								

* Not available

Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board

Los Angeles Times

FRIDAY MORNING, FEBRUARY 24, 1942 — DAILY FIVE CENTS

SUBMARINE SHELLS SOUTHLAND OIL FIELD

An almost forgotten incident of World War II occurred on February 24, 1942, when an enemy submarine surfaced off Southern California's coast and shelled an oil field with its deck guns—then submerged and escaped to sea.

Only a few thousand people lived within range of that sub's guns. Today, from that same offshore location, an enemy submarine of the latest type could launch long-range missiles with atomic warheads to devastate target areas any place in our 17 westernmost states (population 40,000,000).

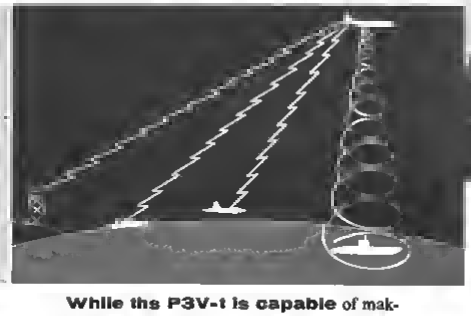
The Navy foresaw many years ago that *every* U. S. citizen would someday be vulnerable to atomic missiles launched from enemy subs—and initiated an aggressive Anti-Submarine Warfare program to negate that threat.

For 14 years land-based patrol planes—P2V Neptunes, designed and built by Lockheed—have been the backbone of the Navy's sub hunter-killer forces. Able to detect even submerged subs, the P2V Neptunes patrol vast ocean areas, night and day, routinely flying through storms and hurricanes that keep other aircraft out of the skies.

Lockheed has more experience in designing and manufacturing Anti-Submarine Warfare planes than any other company. It has more in-being facilities for producing ASW planes than any other manufacturer. Lockheed can build new and better ASW planes—in *less time* than anybody else, and for *fewer defense dollars.*

Sitting at master display scope, Navy in-flight situation co-ordinator keeps track, second-by-second, of unidentified submarine until arrival of co-operating surface, sub-surface, and air units.

World's most efficient and formidable sub hunter-killer plane—a direct design descendant of performance-proved ELECTRA—P3V-1 is being developed for the U.S. Navy.



While the P3V-1 is capable of making kills of enemy subs, unaided, one of its vital missions is to provide co-ordination for anti-submarine units within the search area.

LOCKHEED AIRCRAFT CORPORATION, CALIFORNIA DIVISION

Burbank and Palmdale, California

ANTI-SUBMARINE PATROL PLANES • JET FIGHTERS • JET TRAINERS • LUXURY AIRLINERS
AIRBORNE EARLY-WARNING AIRCRAFT • PROP-JET TRANSPORTS

LOCKHEED

SHORTLINES

►**Allegheny Airlines** reports year-end 1958 passenger miles flown at approximately 90 million, a 10% gain over 1957. The airline carried nearly 500,000 persons during the year, completed over 45,000 hr. in the air with no accidents for the year and carried some 3 million lb. of air freight. Air express and freight was over 5,600,000 lb.

►**American Airlines'** executive vice president-finance, William J. Hogan, says the carrier expects a 10 to 15% gain in traffic and revenues in 1959 over 1958. The airline executive says American's total revenues will be approximately $385 million. Hogan based his optimism on a continuing industry recovery from the slump of 1958.

►**British Overseas Airways Corp.** has announced a new, speedier facility for handling air freight shipments within England and on transatlantic routes. The airline's vans will call at the major London railway stations at 7:30 p.m. daily to pick up shipments from provincial manufacturers for shipment on BOAC's planes to New York. These shipments will be processed and dispatched on the same night.

►**Flying Tiger Line** has applied to the Civil Aeronautics Board for an all-cargo freight and mail route across the Pacific. Flying Tiger would schedule flights from Los Angeles and San Francisco to intermediate points in Hawaii, Wake Island and Guam and the terminal points at Manila and Tokyo. The petition also asked for Taipei as an additional intermediate point and Hong Kong as the additional terminal point. The carrier would use its Lockheed 1049Hs on the routes.

►**KLM Royal Dutch Airlines** carried approximately 940,000 passengers during 1958, 27,000 more than in 1957. Air freight rose from 24,992 tons in 1957 to 26,000 tons in 1958.

►**Pan American World Airways** reports that its Boeing 707 transatlantic flights are carrying close to five tons of cargo plus near capacity passenger loads. Pan American cited flight 114, between New York and Paris, which in the first 15 days of December carried 117,291 lb. of cargo and mail while operating with a seat factor of above 95%. An average of 7,819 lb. of cargo and mail was carried on each flight.

►**Western Air Lines** reports a new company daily passenger boarding record occurred on Jan. 4, when 6,393 persons flew from terminals throughout the company's system in 13 states.

AIRLINE OBSERVER

►Used-plane dealers will receive an encouraging lift from a survey conducted by the Civil Aeronautics Board. Final report of the Board's findings, which will not be published until adopted by the Air Coordinating Committee, points out that the used plane market is not as dismal as previously thought (AW July 7, p. 26). The report finds that a number of firm sales and leases of aircraft are under way and that dealers with money are not shying away from the used-plane market's investment potential.

►Federal Aviation Agency organizational structure is attracting industry attention because of its lack of a chain of command (AW Jan. 5, p. 30). All bureaus, divisions and assistant administrators report directly to the FAA Administrator Elwood Quesada and his deputy.

►Pan American World Airways has asked Douglas Aircraft for a proposal on a cargo version of the DC-8 turbojet transport for lease to the Air Force. If an order follows, it would total about 30 aircraft. Douglas has been asked to submit engineering proposals with and without a swing tail cargo loading entrance.

►Brazilian government has invited International Air Transport Assn. members in the Western Hemisphere to a meeting Jan. 19 in Rio de Janeiro as a first step toward finding a solution to the price-cut war on South American air routes. Civil Aeronautics Board will be represented at the session by vice-chairman Chan Gurney and Irving Roth. Prompter of the meeting is Ruben Berta, president of Varig Airlines.

►Promotional schemes and creative fare plans designed to tap new air travel markets will hit an all-time high in volume this year as airlines prepare to cope with increased competition resulting from expanded schedules, more available seat miles and improved aircraft utilization.

►Airline common stock listed on the New York Stock Exchange continue to hit new highs in a rising market. Of all trunklines listed, only Eastern Air Lines lagged more than two points below 1958-59 highs as of late last week.

►Airline traffic continued strong through the first two weeks of January. Favorable weather on a number of major route segments has helped prevent the normal heavy post-holiday dip in traffic volume.

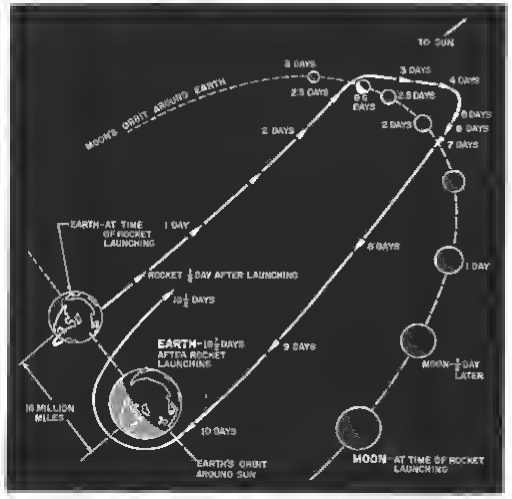
►American Airlines is not postponing inaugural date of its transcontinental jet service as a result of pilots' strike (AW Jan. 12, p. 38). However, the company has been forced to cancel plans for community familiarization programs in areas scheduled to be served by the jets.

►Japan Air Lines will send 20 pilots, flight engineers and navigators to Douglas Aircraft for 25 days of flight training in the DC-8 simulator beginning Mar. 2.

►Civil Aeronautics Board this week begins the move to new quarters in Washington that will bring the entire agency under one roof for the first time in its history. Although the new quarters—fifth to 10th floors in the recently completed Universal building—are well outside the Federal Triangle area in central Washington, facilities will be more modern and spacious than old location in Commerce Department Building.

►Air France will begin Caravelle turbojet London-Paris and London-Nice flights late this summer. Although no inaugural date has been set, service will not begin before Aug. 15.

►Average number of passengers per aircraft on domestic and international operations of foreign and U. S. carriers remained the same in 1958 as in 1957 after consistently climbing each year since 1948. Average the past two years was 29 as compared with 13 in 1945, 17 in 1948. Total is expected to climb to 31 this year.



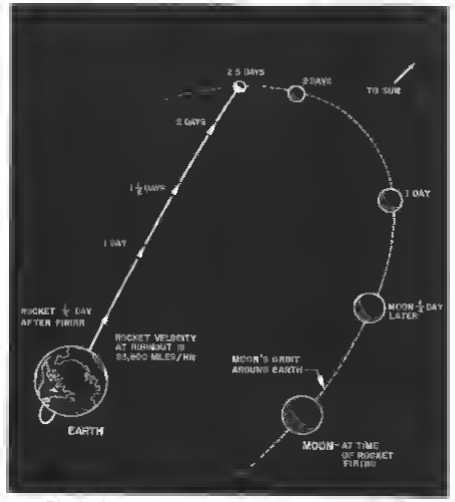


FIG. 1 (left) shows a possible trajectory for single circumnavigation of the moon. Fig. 2 (right) shows a trajectory for an impact on the moon. Circumnavigation is the more difficult of the two to achieve. Unless a trajectory could be computed that would use the moon both as a retardation and capturing mechanism, the vehicle must carry a rocket to be used as it nears the moon's vicinity.

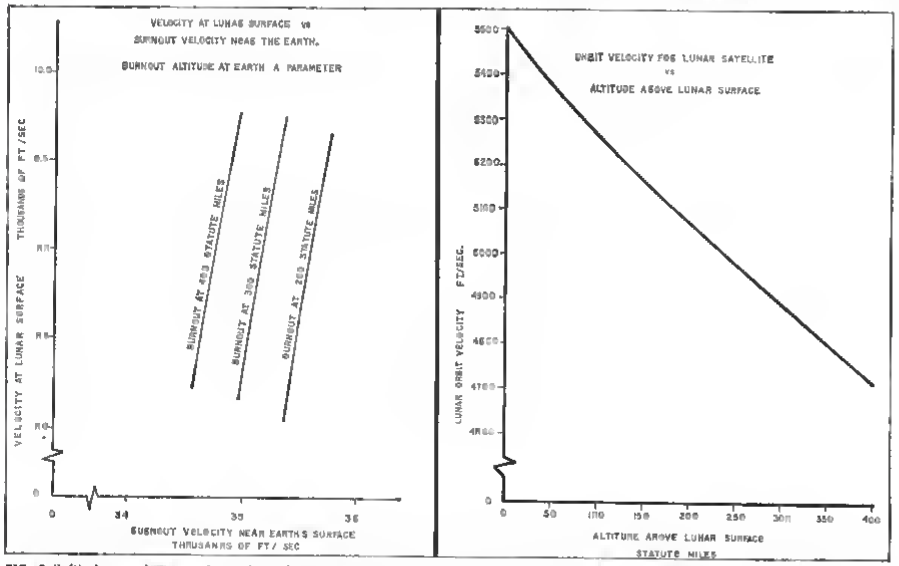


FIG. 3 (left) shows velocity at the surface of the moon vs. burnout velocity near the earth. Fig. 4 (right) shows orbit velocity around the moon vs. lunar altitude. Velocity at moon's surface is affected by burnout velocity and burnout altitude. These, plus any errors that occur during the retardation procedure, will determine nature of lunar orbit.

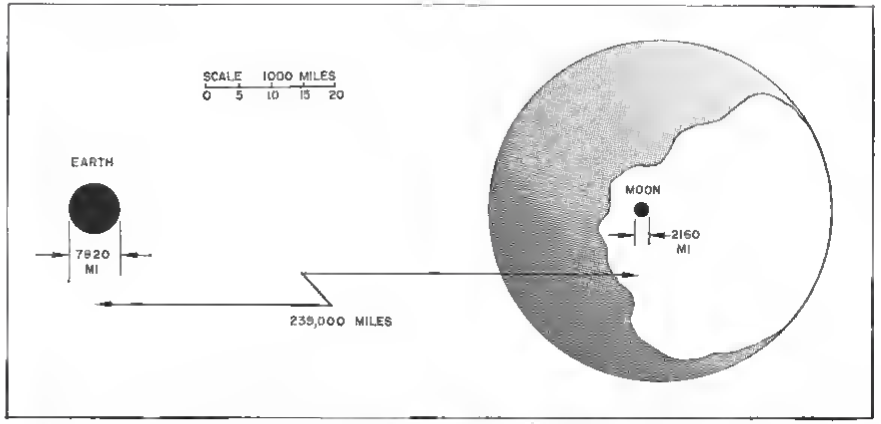


FIG. 5 shows the Influence Surface between moon and earth. It contains those points where gravitational forces of the earth and moon, excluding the sun, are equal in magnitude. On either side of this surface, vehicle will be under the influence of one body or the other.

Trajectory Governs Moon Shot's Value

By S. B. Kramer

The possibilities resulting from launching a vehicle to the moon or to its vicinity are many. As current articles have indicated there is a multiplicity of missions, paths, and intents.

There are, perhaps, four general possibilities in the class of simple trajectories for unmanned lunar probes:

- Orbiting the moon several times and (a) not returning to earth or (b) returning to earth or its vicinity.
- Pure impact—hard landing.
- Circumnavigating the moon once and returning to or near the earth.
- "Flying" past, close to the moon, without returning.

Many more possible missions may be added to the list, but these will get progressively more difficult and consequently will have less chance of success.

Defining Lunar Orbit

Many of the articles offered to the public have contained a major inference that the establishment of an orbit about the moon is the easiest task to perform. However, it is essential that "orbiting the moon" be defined in a more restricted sense than that implied by the phrase.

A scientifically useful orbit for a mission, such as scanning the surface with an infrared device (using the IR system available in 10-15 lb. of instrumentation similar to the one carried by the Air Force Pioneer I rocket) probably should come closer than 400 mi. from the lunar surface so that some reasonable definition of the topography may be ascertained.

The circumnavigation of the moon at any altitude is no mean accomplishment, and its value is not lost upon us. Nevertheless, one must appreciate the fact that there are differences in values of orbits at great altitudes, i.e. 5-10,000 mi. and more, and that those much closer to the moon are bound to yield data incomparably more useful.

Because both the moon and the vehicle are in motion in this problem, it is suspected that some trajectory could be determined wherein orbiting of the moon might take place without the use of any vehicle retardation devices.

The moon itself would act as retardation and capturing mechanism.

Although the severity of the problem may be lessened by using such equipment as retrorockets, still the guidance demands for orbiting are not easily met. Suppose that no device was used to alter the path after burnout of the launching vehicle near the earth. If in addition, burnout took place at an altitude of 350 statute mi. from the earth's surface, then the demands for initiating a lunar orbit within 100 statute mi. of a reasonable orbital altitude (about 800 mi.) are either four feet per second in velocity at burnout or two hundredths of a degree in the direction of the velocity vector at burnout[1].

Since the would-be lunar satellite will

[1] Accuracy Requirements for Trajectories in the Earth-Moon System, H. A. Lieske, The Rand Corp. Report P-1022, Feb. 10, 1957. Trajectories shown in the figures are variations of a series of trajectories from Rand Corp. Reports authored by Lieske, et al.

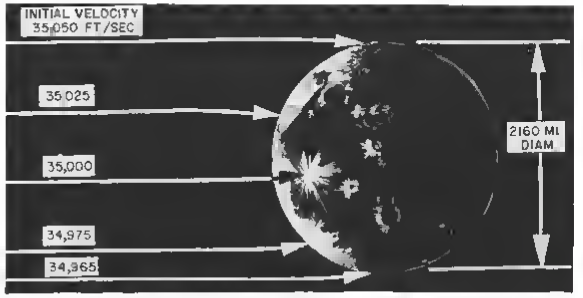


FIG. 6 shows variation in lunar impact for initial velocity errors.

About the Author

Saunders B. Kramer is a physicist/mathematician in the Preliminary Design Department of Lockheed Aircraft Corp.'s Missile Systems Division and has been engaged in satellite work.

This article was prepared prior to the Soviet Union's launching of a lunar rocket on Jan. 2 and is an attempt to clarify misimpressions about the relative difficulties of orbiting the moon and impacting on the moon. It is a general discussion with few absolute statements since trajectories for specific missions must be precisely calculated.

A comparison of U. S. and Soviet satellites by Kramer was printed in Aviation Week last May 26.

require an additional increment of excessive velocity due to its fall through the moon's gravitational field during the approach to a lunar orbit, it will also require a subtraction of such excess velocity to establish this orbit.

Consequently, a retardation device must be used, and it also must perform within specified limits. The approach velocity at the moon's surface, if not retarded, will be 9,000 ft./sec. if the burnout velocity, correctly aligned, is 35,000 ft./sec. at the previously noted earth altitude of 350 statute mi. Fig. 3 indicates the velocity at the moon's surface for various burnout velocities (burnout altitude is a parameter).

Impact Trajectories

Compare the requisites for the orbiting function with those needs delineated for a lunar impact—a hard landing. The impact choice is much less demanding of guidance requirements at the burnout point and requires no further direction of the vehicle if these are satisfied. The velocity accuracy for this case is roughly plus or minus 40 ft./sec., or an angular deviation of not more than one-half degree of the velocity vector at the burnout point*.

Again these specifications are noted for the case of velocity at burnout of 35,000 ft./sec. at an earth altitude of 350 statute mi. An impact trajectory for this case is shown in Fig. 2. The variation in lunar impact for various velocity errors (also for this case) is shown in Fig. 6. Moreover, effects due to the sun are neglected, although such effects are not believed sufficient to cause a miss if the basic error limits noted are not exceeded.

In consideration of an orbiting satellite, deviations from the retardation performance will bring about subsequent variations from the expected

*Ibid. See p. 49

Is your problem

Quality
Maintenance
Reliability
of electronic equipment

Here is your solution!

100% testing
—systems, circuits,
and components—
by Automation

CTI specializes in assuring the reliability of electronic and electrical equipment, whether components or complete systems. Automatic testing, for factory or for ground support, can accurately and completely diagnose electronic systems. Existing and incipient faults are found in far less time than by other quality control or maintenance methods. 90% cost reductions can be expected! Benefit from our extensive experience in adapting automatic methods to test problems, either with equipment designed to your requirements or with our standard equipments.

Tape-Programmed Circuit Testes
Tests electronic and electrical circuits and systems according to values punched in tape
Model 180

Missile Test Console
Continuously monitors circuits of main missile wiring harness undergoing 15 minute vibration test
Custom made

Automatic Circuit Tester
Voltages, impedances, resistances, etc. of complex circuits and equipment are checked on a go/no go basis
Model 100

Missile Check Out
Performs final electrical test on missile guidance head
Custom made

Automatic Circuit Tester
Designed especially for rack mounted test installations, this is another in the series of CTI Supertesters shown above
Model 104

Missile Hi-Pot Test Station
Hi-pots main forward and aft missile wiring harnesses
Custom made

Component Testes
Insertion of a punched card instantly programs test series and test limits for any one of the seven basic electronic components
Model 176

Tape Reader
For programming automatic equipment, this reader provides 80 bits of information at each advance of the punched tape.
Model 171

Cable Testes
Simultaneously measures continuity, leakage, and d-c hi-pot on complex cable harnesses
The latest state of the art in cable testing
Model 165

Tape Punch *and* Tape Duplicates
Facilitates tape programming and, used with above reader, reproduces and speeds editing of tapes
Models 173 and 174

CALIFORNIA TECHNICAL INDUSTRIES
DIVISION OF TEXTRON INC
BELMONT 6 CALIFORNIA
Foremost in Automatic Testing

Engineers: Career opportunities are currently available at CTI

Panel light indicates when radar's ring time exceeds predetermined standard
Other checks can be obtained with frequency indicator and relative power meter.

Make flight-line checks of radars with Sperry's "go, no-go" tester

C and X-band models available for immediate delivery

Here's the fastest means yet developed for testing aircraft radar on the flight-line or in the field. It's the new Sperry Microline® Radar Performance Tester and anyone can use it—no special training is required.

Weighing only 24 pounds (30 for C-band), this tester is self-powered (standard batteries) and is easily carried about. It prevents costly delays by providing a quick, over-all check of all aircraft radars in only minutes.

This is the only performance tester that checks the alignment between transmitter and receiver positively and accurately by flipping a single switch. Interchangeable plug-in echo box cavities permit checking either C or X-band radars. Transistorized circuits with built-in testing feature contribute to light weight and reliable performance.

If you'd like to know more about the new Sperry Microline Radar Performance Tester, write to our Microwave Electronics Company.

SPERRY

SPERRY MICROWAVE ELECTRONICS COMPANY, *CLEARWATER, FLORIDA • DIVISION OF SPERRY RAND CORPORATION*
Address all inquiries to Clearwater, Florida, or Sperry Gyroscope offices in New York • Cleveland • New Orleans • Los Angeles • San Francisco • Seattle

orbit. The lunar orbit will require an orbiting velocity in the neighborhood of 5,000 ft/sec. Fig. 4 shows the orbiting velocity as a function of height above lunar surface for circular orbits.

Errors that occur during the retardation procedure, together with the initial faults at burnout, then determine the nature of the lunar orbit. Matters such as consideration of the effect of the gravitational gradient due to the sun have been neglected in this discussion but of course should not be neglected if a precise orbit is to be defined.

This brief discussion serves to indicate rather roughly the problem faced in attempting to create a satellite of the moon. Nonetheless, from the comments however simplified, some insight into the desideratum for the task should be fairly apparent.

Returning to Earth

Many remarks in the general press have alluded to the nature of trajectories of a lunar satellite on its return to earth after several orbits around the moon.

Since few, if any, specifications on the class of orbits concerned with such return trajectories are given, it becomes necessary to relegate such possibilities to their proper place in the over-all tableau.

Thus, if it were established that the lunar orbit altitude was great (10,000 mi. or more), then perhaps the disturbing influence of the sun would upset the orbit in a relatively short time, and quite possibly the vehicle would return to the vicinity of the earth.

Again several choices may exist re-entry into the earth's atmosphere and destruction, a close-in orbit around the earth, a highly eccentric orbit about the earth, or finally an orbit about both moon and earth in any of a variety of trajectories.

Alternately, the lunar orbit may well be a path relatively close to the surface at an altitude of 2-300 mi. More than likely such an orbit would be established with the use of some mechanism capable of reducing the approach velocity of the vehicle and of guiding into the desired path. This positioning would result in the vehicle becoming a captive of the moon permanently.

Neither the sun nor the earth would then have sufficient persuasion to perturb such a vehicle to the extent of bringing it back to the neighborhood of this planet. The prerequisite for a change of path to induce the vehicle to return to earth would be the addition of sufficient energy to render the desired performance. The obvious method would be to add the original quantity of energy subtracted by the retrorocket in initiating the orbit when the vehicle is properly positioned for a return to

earth presumably again using rocket motor

The case for a single circumnavigation as generally noted in Fig 1 is merely a special instance of the previous situation in which the vehicle must be slowed for a close approach for scanning purposes and then speeded up for the return trip An alternate choice would bring the vehicle near the lunar surface for a short interval (the grazing case), and then would accelerate it into a highly eccentric orbit returning it to the vicinity of the earth

Let us describe a surface defined by those points where the gravitational forces of the earth and the moon excluding the sun are equal in magnitude This surface can be called the Influence Surface On either side of this surface the vehicle will be under the predominant influence of one body or the other This surface is shown diagramatically in Fig 5

The sun's effect on the location of this surface is negligible, for the surface is only some 110 mi closer or further from the moon depending upon whether the moon is between the earth and the sun or is behind the earth as seen from the sun

Though one body or the other is described as having a dominating influence within (or without) this surface actual trajectories are a matter of precise calculation What can be stated rather positively is that vehicles within the surface will not necessarily be captured by the moon's gravitational field

Should we choose to consider trajectories that yield orbits at great distances from lunar surface of the order of 20 000 mi then the role of the sun is noticeably different Since the vehicle-earth-moon system is non-conservative, i e the potential energy of the vehicle is a function of time inclusion of the sun will determine whether or not stable orbits of this type can exist The characteristics of each situation of this class necessitate careful scrutiny and extensive calculations before results may be ascertained with any degree of certainty

The case for just grazing the moon and not returning to the earth at all implies an excess of velocity properly directed for a quick "look" at the moon and a probably subsequent injection to some sun centered orbit

It is worth noting that at the present time the moon's perigee is located between the earth and sun roughly on a line connecting the earth-sun centers Since the lunar perigee takes 9¼ years to rotate once in the lunar orbit, a long period is available for the current attempts to reach or encircle the moon In particular January (the month of highest tides), when the earth and moon are nearest the sun will be a most propitious time for lunar probes

Missile Spending May Slow, Report Says

New York—Missile growth in the financial sense may be reaching a leveling off point, indicates a report from Smith, Barney & Co., an investment firm often associated with aviation financing.

Missile spending may have already begun slowing down, the report said, pointing out that since Fiscal 1956 the year to year rate of increase has been decreasing.

The report, sent to the printers just prior to recent missile cancellations, noted that the Department of Defense was encountering increasing difficulty in obtaining funds to support parallel or competing missile developments.

"Missile spending is now about one third of the military (aircraft) shopping list," the report said. "Conservative procurement policy may see this ratio as an upward limit during periods like the present when 'border incidents' or 'local disturbances' or 'police actions' are far more likely than general war."

It is no longer useful to think only in terms of manned or unmanned aircraft, the report said, for men will soon be piloting vehicles such as the North American X-15, which would have been called missiles not so long ago. "Perhaps," it said, "the more useful distinction lies between aircraft with piston or turbine engines and aircraft with rocket engines."

The report commented on two problem areas in the aircraft industry.

• **Renegotiation.** Some refinements in the renegotiation process were held probable, but there was doubt basic criteria would change. In effect taking issue with the industry's attack on renegotiation, the report said that, as applied, the law had allowed a return on equity that compared favorably with many other industries. Aircraft manufacturers have agreed the return on equity has been comparable, but pointed out that the industry has traditionally had a narrow equity base. The industry has stressed profit margin on sales, which has been low.

• **Capital needs.** Progress payment decline, increase in cost plus contracts and need to invest in special facilities and research have put a heavy strain on the industry's financial resources, the report said.

"Several major companies have recently come to market with large issues of securities," the report said. "In itself the volume of public financing does not seem excessive.

"However, this remains a contracting industry, subject to torrential changes of fortune, and a heavy amount of permanent capital can sometimes prove embarrassing when the contractor runs out of orders. More financing is probably necessary. It is a trend to be watched carefully (AW July 7, p. 54).

"Particularly important is the industry's enormous investment in commercial jet transports, an investment that seems to be in jeopardy because of the weak financial conditions of the airlines that ordered them."

The bulk of the report was devoted to comments on specific companies from the investor's point of view. These included:

• **Beech Aircraft.** Beech, like Cessna and Piper, was regarded favorably because of its participation in the growing business plane field. However, Beech's commercial outlook was held as unduly burdened with problems in military volume, which is 65% of its total sales. Cessna's military volume last year was about 48% of sales and was considered more favorable. Piper's sales were 97% commercial.

• **Boeing Airplane Co.** Boeing's very strong military prospects were noted in detail, but the report also pointed out the problems of the producers of large commercial transports. The 707 jet transport accounts for 31% of Boeing's $2.8 billion backlog, but because of cost increases the company estimates it may not make much profit in production.

• **Fairchild Engine & Airplane Co.** is another example of commercial transport problems. "Total orders for the F-27 are believed to amount to about 90," the report said, "but the firmness of the orders depends on the financial strength of the local service airlines—historically a weak industry in financial terms. At present it is doubtful that Fairchild will break even on the F-27 program."

• **Curtiss-Wright.** About half its earnings at peak in 1956-57 came from the Turbo Compound engine for Douglas DC-7s and Lockheed Constellations, now out of production. "Curtiss-Wright has virtually given up the aeronautical and military fields in an effort to secure commercial business," the report said. "It is a tribute to Curtiss-Wright's imaginative and versatile management that the company has successfully linked the pioneer names of Orville Wright, Wilbur Wright and Glenn Curtiss with the modern production of plastic items for underwear and inspection systems for railway car axles."

Backlog declined from more than $1 billion in 1953 to $346 million last March and was not reported in June. The report said the outlook is for further diversification, but is difficult at the moment to see a definite product line developing.

• **Douglas Aircraft Co.** Douglas has been burdened by declines in military aircraft backlog—down from $1.8 billion at peak in 1953 to $474 million last year—and development expenses on the Douglas DC-8 jet transport with more than $100 million written off by mid-1958. With sales expected to decline this year, the report suggests avoiding the common stock at current prices. (This view is not shared by others on Wall Street. One analyst pointed out that Douglas may have had all its bad news, and the dividend cut was behind it. Thus the stock may actually be entitled to a technical rebound.)

• **Thiokol Chemical Corp.** Noting the slowing of missile spending, the report advised careful consideration of this situation's possible effect on Thiokol. Granting the excellent technical and financial performance of the company so far, the report pointed out the current price of the common stock—about 50 times current earnings—may have more than discounted the large growth potential still in the company.

Cherington Stresses Price Structures

Airline fare structure, as opposed to fare levels, is likely to be ignored in the current General Passenger Investigation of the Civil Aeronautics Board, Prof. Paul W. Cherington believes.

This is regarded as unfortunate by Prof. Cherington, author of the Cherington report on airline financing. In a new study of airline price policy[1] he points out that changes in structure might be more essential than changes in levels.

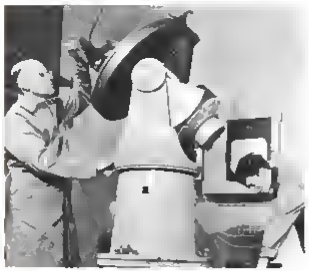
Airline approach to the problem has been unsystematic and that of the CAB sporadic and largely negative, he believes. On the CAB credit side, however, he points with favor to the Board's permitting the initiative in the

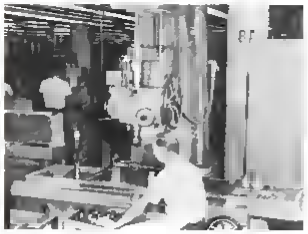
[1] Airline Price Policy, a Study of Domestic Passenger Fares published by The Division of Research, Graduate School of Business Administration, Harvard University. $7.50.

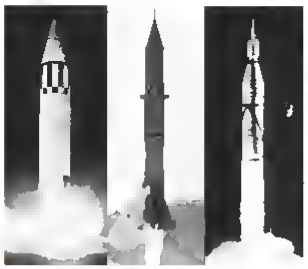
Ford Instrument aero-space capabilities

Wide experience in these vital new missile and aero systems equips Ford Instrument for major responsibility in the most advanced fields

Ford Instrument Co , Division of Sperry Rand Corporation, offers defense agencies a background of *44 years' continuous experience* in initiation, development and quantity production of military equipment and weapons control systems Today, in the dawning space age, Ford Instrument experience, as outlined in the illustration opposite, already encompasses a wide variety of activities in the forefront of this field Notable are inertial guidance and control systems for the U S Army Ballistic Missile Agency's REDSTONE and JUPITER missiles, developed with ABMA and manufactured by Ford Instrument, many guidance and control components on the Army's satellite-launching JUPITER C, navigational systems in wide operational use by the U S Air Force, and many highly advanced activities such as research into new types of inertial guidance systems for USAF s WADC Weapons Guidance Lab



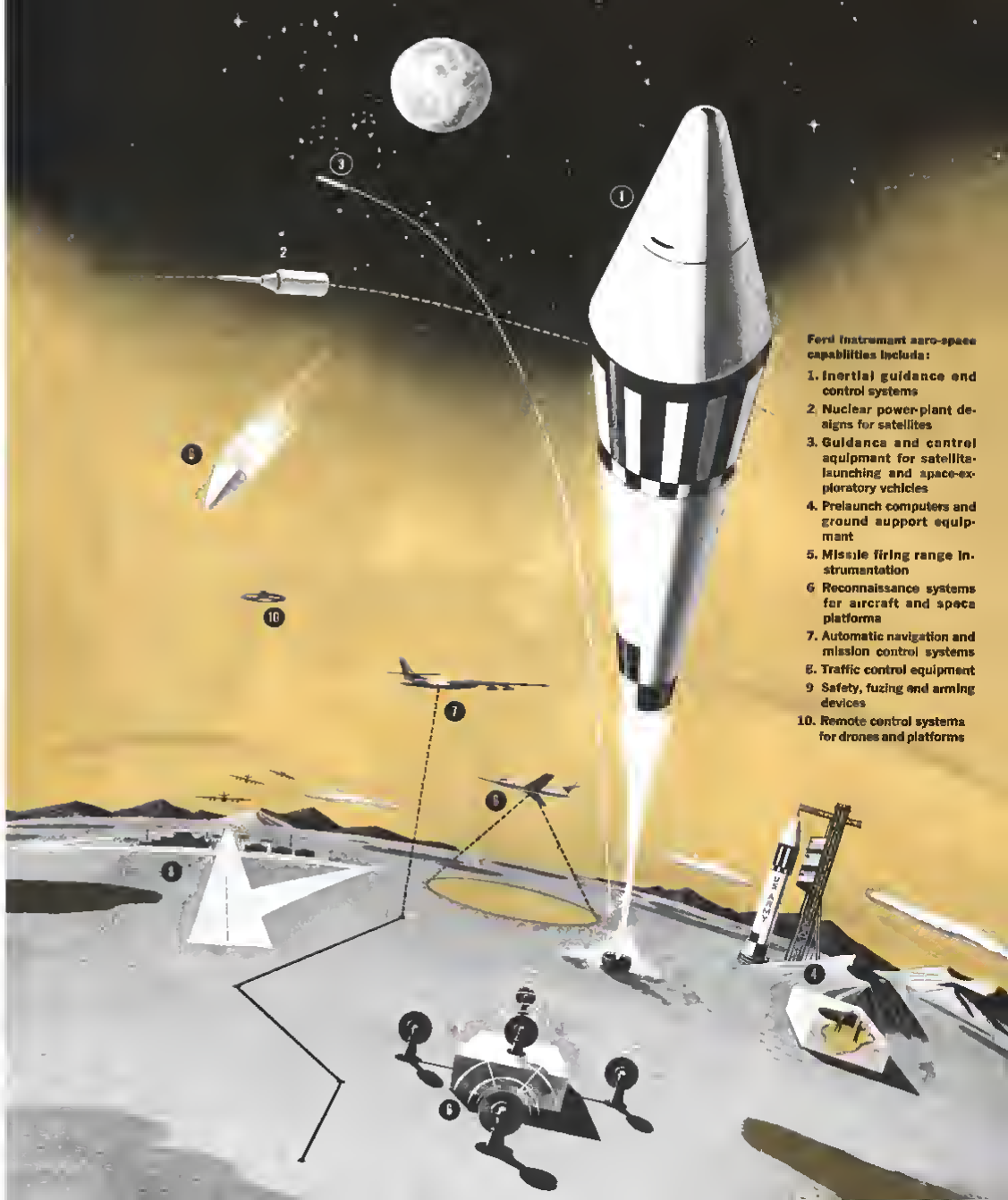




DEVELOPMENT — *Top photo* Gyro for stable platform under test in development lab. Ford Instrument is also designing advanced inertial guidance systems incorporating new concepts

MANUFACTURING — *Center photo* This photograph shows machining of piece for JUPITER stable platform in one of Ford Instrument's many precision production shops.

END USE — Ford Instrument manufactures guidance and control systems used in JUPITER *(left)*, REDSTONE *(center)* and many similar components in JUPITER C *(right)* Ford Instrument has worked closely with the U S Army on these ABMA developed missiles *(U S Army photos.)*



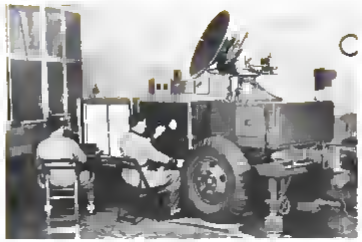
Ford Instrument aero-space capabilities include:

1. **Inertial guidance and control systems**
2. **Nuclear power-plant designs for satellites**
3. **Guidance and control equipment for satellite-launching and space-exploratory vehicles**
4. **Prelaunch computers and ground support equipment**
5. **Missile firing range instrumentation**
6. **Reconnaissance systems for aircraft and space platforms**
7. **Automatic navigation and mission control systems**
8. **Traffic control equipment**
9. **Safety, fuzing and arming devices**
10. **Remote control systems for drones and platforms**

Ford Instrument ground systems capabilities

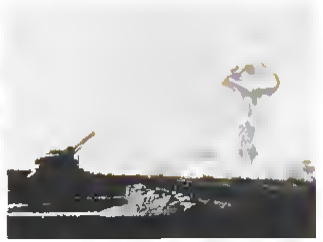
New methods of attack on military problems require a wide range of engineering skills . . . mechanics, electronics, optics, computer technology

New weapons and materiel are changing the techniques of ground warfare today as at no time in past history. The unique capabilities of Ford Instrument in automatic control and computer systems are being put to use in implementing and shaping new concepts of ground warfare. Some of these capabilities are shown in the artist's conception below. Notable Ford Instrument experience includes: Development of a system for control of aerial drones for combat surveillance and reconnaissance, development of a computer for vehicle navigation in trackless wastelands, and inertial guidance and control for the REDSTONE tactical ballistic missile.

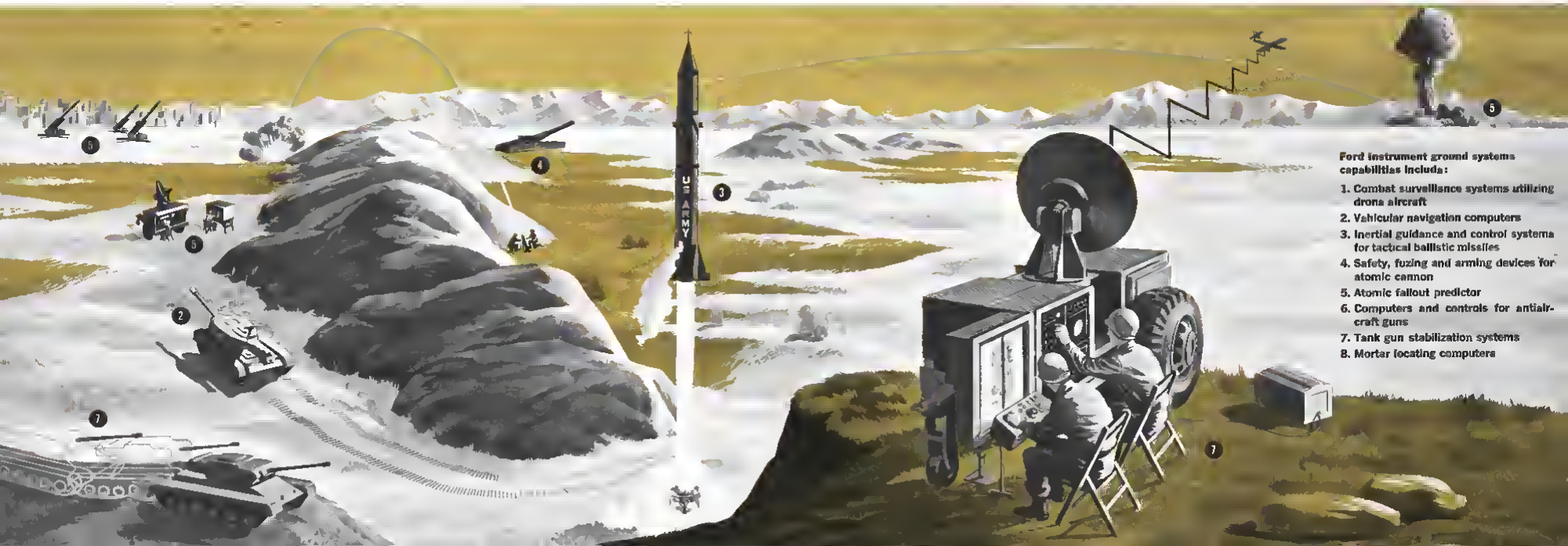


DEVELOPMENT—Trailer for combat surveillance (drone control) system. Ford Instrument worked with U.S. Army Signal Corps on this system, comprised of radar, tracking, telemetering, computing, plotting and control equipment.

MANUFACTURING—A step in the manufacture of a precision computing cam. Ford Instrument has extensive facilities for precision machining, is widely experienced in both electronic and mechanical computer techniques.



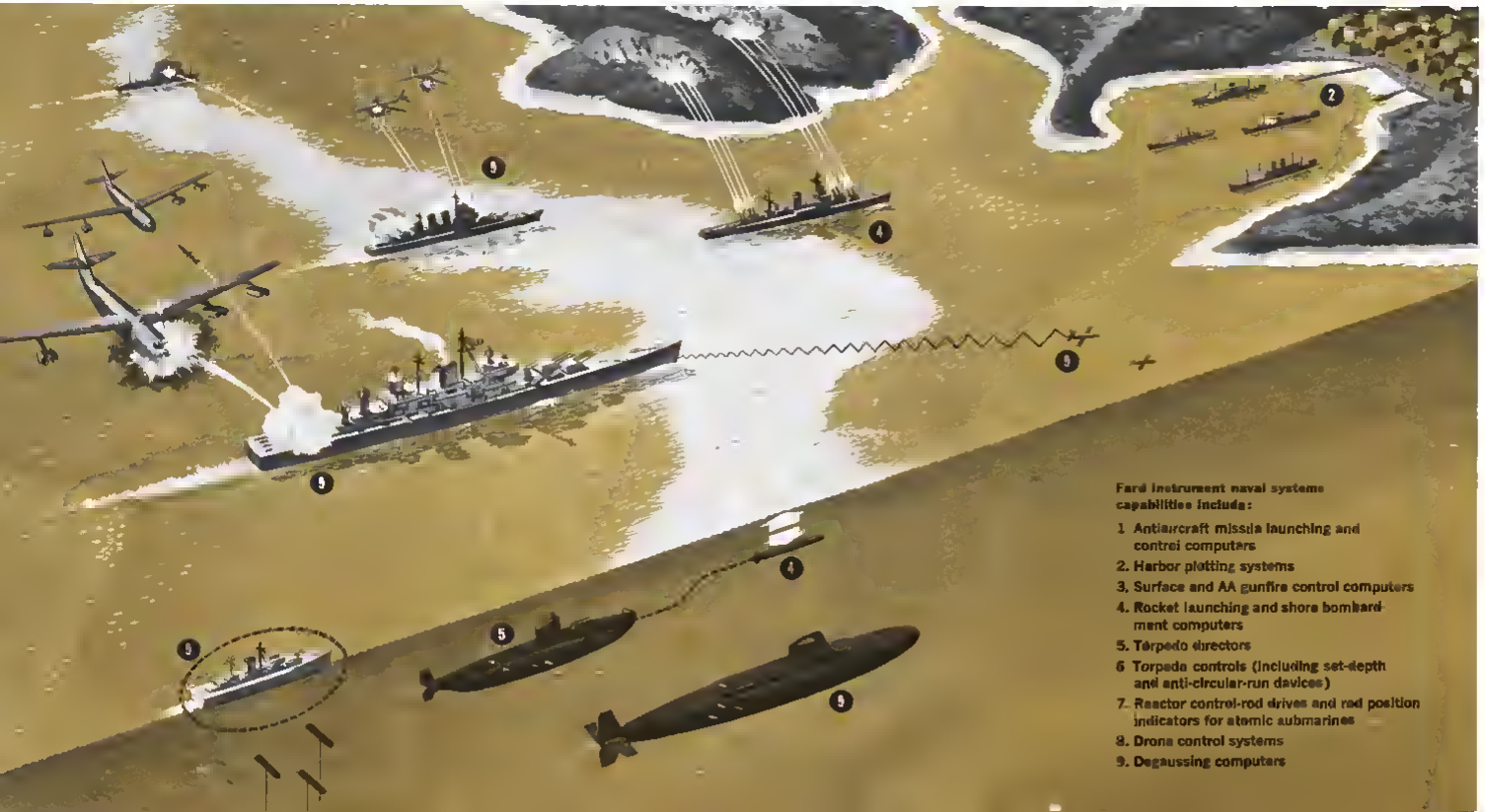
END USE—U.S. Army atomic cannon shown at test firing. Ford Instrument developed and produced complex safety, fuzing and arming device for this weapon, is one of few companies with wide capabilities in warhead control work. *(U.S. Army photo.)*



Ford Instrument naval systems capabilities

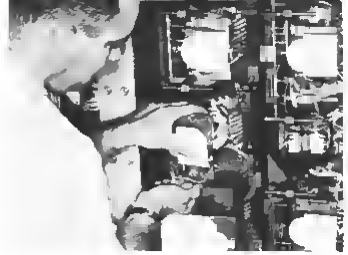
Ford Instrument has over four decades of experience in development and production of complex computer and control systems for U. S. Navy weapons

Ford Instrument experience in naval systems encompasses complex equipment for all phases of naval warfare—surface, air-defense, and underwater. Ford Instrument's long history of working with the U. S. Navy began with manufacture of one of the earliest analog computers for solving fire control problems (Range Keeper Mk 1, *circa* 1915). Today, Ford Instrument's naval systems activities continue with development and production of such vital modern equipment as the launching and control order computers for the Navy TERRIER and TARTAR missiles, control rod drives and other instrumentation for atomic submarines, plus a wide variety of operational fire control equipment for naval guns and rockets. Some of these advanced naval capabilities are shown on the panorama below.



Ford Instrument naval systems capabilities include:

1. Antiaircraft missile launching and control computers
2. Harbor plotting systems
3. Surface and AA gunfire control computers
4. Rocket launching and shore bombardment computers
5. Torpedo directors
6. Torpedo controls (including set-depth and anti-circular-run devices)
7. Reactor control-rod drives and rod position indicators for atomic submarines
8. Drone control systems
9. Degaussing computers



DEVELOPMENT—*Photo above.* Electronic section of the all-transistor computer developed to solve launching and control order problems for TARTAR missiles. Note ultra compact modular construction which greatly facilitates maintenance.

MANUFACTURING—*Top photo.* A technician makes final check out on Mk 47 AA and surface gunfire control computer before delivery to U.S. Navy. Ford Instrument is one of a few companies having thorough experience on *all* types of computers and control systems—electronic, electro-mechanical, mechanical, hydraulic.

END USE—*Left photo.* Night firing of U.S. Navy TERRIER missile. Ford Instrument is proud of its part in the production of the vital TERRIER TARTAR weapons systems for fleet air defense. *(U.S. Navy photo.)*

price area to remain with the airlines. This freedom, he says, should be enlarged in the future and the airlines urged to use it.

Forecasting a bitter competitive struggle for traffic because of recent route awards and new equipment, Prof. Cherington urged more intensive and systematic marketing analysis by the carriers, which has not been characteristic of them in the past.

The last such critical period for the airlines, the late 1940s, produced coach service, he said, but its hit or miss development took 10 years. Now the matching of price with classes of service is tending to become obscured, and the introduction of jet equipment may require a third class of fares. These might be first class, regular coach and off-peak (hourly, daily or seasonal) coach. As for the regulatory climate, Prof. Cherington made these points:

• **Though CAB** has often lectured the carriers on the need to look at fares and profits on a long run basis, it has seldom done so itself.

• **Interaction** between CAB's pricing policies and policies in other fields. For example, CAB has rarely, if ever, in a route case considered fare reduction as an alternative to certificating competing carriers on the route.

• **Handling** of pricing matters in essentially an adversary proceeding is open to question. The CAB staff's assumption of the role of defending the public interest may be pointless since the public itself is never consulted as to whether it would rather have improved service at the same or higher fares or the same service at lower rates.

One point the study makes is that small prices changes within a class of service lead to little change in traffic volume. Progress in the pricing field appears thus to demand considerable marketing imagination on the carriers part. As part of its recommendation, the study urges that the carriers establish a price policy staff to review prices continually and help maintain an adequate balance of marketing and financing considerations in pricing decisions.

Tight Market Hampers Airline

Outlook is gloomy for Hawaii's two local service airlines because of competitive pressures in a market big enough for only one, Arthur D. Lewis, president of Hawaiian Airlines believes.

Hawaiian, one of the two carriers, plans to convert its Convair 340s to turboprop Convair 540s to compete with Aloha Airlines which plans to buy three Fairchild F-27s. Aloha last month formally changed its name from Trans Pacific Airlines.

Hawaiian can modify its Convairs for about $500,000 each, Lewis told the Investment Society of Hawaii, or a total cost of $2,250,000. This compares, he said, with a cost of $800,000 for a new F-27 or $1,200,000 for a new Convair 540, built by Canadair Ltd.

Lewis did not disclose which conversion of the airplane might be used. Allison has been firming D501 turboprop engines on an Air Force C-131. Napier is offering an Eland conversion which would be done by PacAero Engineering Corp. of Los Angeles.

Total investment by both carriers in turboprops will be about $6 million, Lewis said. This alone will mean increased subsidy of $1,400,000, which represents an increase of 20% in the total passenger revenues of both inter-island carriers for 1957—a large sum to be raised for this purpose alone either by higher fares or subsidy, in Lewis' opinion.

There is no question in my mind that if competition continues between the two inter-island carriers," Lewis said, "both carriers will need subsidy in large amounts and for a long period."

Merger attempts have been tried. They ranged from pure merger with a stock exchange to an offer by Hawaiian to purchase the assets of Aloha for cash. The attempts failed.

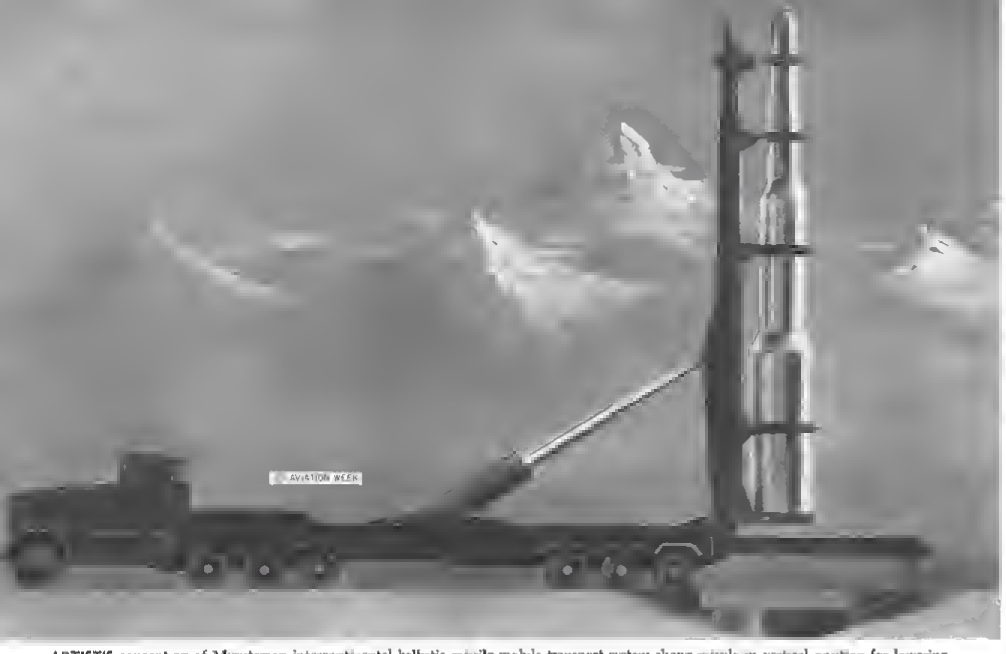
Inter-island traffic is growing at a slow rate, Lewis said, and the rate of growth is falling. Waikiki visitors are increasing, but the percentage going to other islands in the chain is declining. Lewis said that Hawaiian is not optimistic about future traffic growth.

The airline industry in Hawaii is a depressed industry," Lewis said. "This is so because the market is small and does not have the dynamic characteristics needed to support a duplication of service by two carriers. Since the service by the second airline was inaugurated in 1949, there have been subsidy payments of $3,455,000 to the two airlines, yet even so there has been an aggregate operating loss of $167,000 for the 10-year period."

The consequent outlook with Aloha forcing re-equipment by both carriers, affords little prospect for profit, Lewis asserted.

Martin Gets Production Contract for P5M-2

Baltimore—The Martin Co. has received a $23 million Navy contract for production of P5M-2 anti-submarine warfare seaplanes. The P5M-2s will be equipped with a new submarine detection system, probably Jezebel radar sonar equipment. French government also has contracted for a number of P5M-2 aircraft.



ARTIST'S conception of Minuteman intercontinental ballistic missile mobile transport system shows missile in vertical position for lowering into underground silo. Missile would be raised by hydraulic ram fitted on truck trailer bed

Minuteman Site Poses Critical Challenge

By Irving Stone

Los Angeles—First true "pushbutton" weapon system, Air Force's huge solid propellant Minuteman intercontinental ballistic missile project, is facing development of its most critical phase: ground environment.

Overall concept for this weapon system is extremely simple, with Minuteman ICBMs almost instantaneously ready to blast out of underground silos hard-based in strategic locations of the U.S. But the ground environment details to make this pushbutton retaliatory potential possible will be the greatest technical challenge of any weapon looming on the development horizon. By comparison, the missile will be a simple and inexpensive item.

Scheme for an almost invulnerable system to permit this fast retaliation is of overall intricacy. The tremendous problem will be refinement of the system scheme into interrelated details which will permit the very high reliability requirement involved in truly effective retaliation, which could mean the difference between survival and extermination.

There's no doubt that top reliability can be attained. Ability to achieve it is available—no "breakthrough" will be required, merely a huge, intense analytical engineering job. But as in any project compromises will be involved. In the case of Minuteman these compromise factors will depend on money available, talent apportioned to the ground environment phase, and time-scale to achieve operational readings. Some observers feel that ability to create an effective ground environment plan for a reasonable expenditure of money will be the most decisive factor in the entire Minuteman program.

Experience amassed with liquid-fueled ICBMs indicates that the Minuteman weapon system could be brought to operational status within the same period as for a weapon such as the Atlas, which was put under contract in January, 1955, and may achieve strategic readiness sometime in 1959 or early 1960.

Contracts for Minuteman—engines (Thiokol, Aerojet, General), nose cone guidance (North American Autonetics Division), and assembly and test (Boeing)—have only recently been let so that, by comparison, weapon system readiness may be projected for some time in 1962. But some observers feel that intricacy of the ground environment development will not permit establishment of this time scale as a true target unless the highest priority and effort is put on this development phase.

In initial analysis of the Minuteman system, tendency probably was to lean toward the idea of having a separate ground environment contractor. But with continued study of the system and initial development of its components more light has been shed on the interrelated functions of the ground environment contractor, the assembly and test contractor, and Air Force's Ballistic Missile Division, which is the coordinating military agency.

Reappraisal of the situation now leads observers to believe that the ground environment phase might best be coordinated among the various prime contractors, mainly with the assembly and test contractor. This arrangement probably will result in some of those companies which had hoped to be considered for the job of separate ground environment contractor to team as a subcontractor with the assembly and test contractor for development of ground environment installations and equipment.

Ramification of the ground environment phase points up the necessity of development of the various factors involved concurrently with development of the missile itself because of their fundamental interrelation. This means that over-all planning for the comprehensive environment must be coordinated as early in the program as possible if delays and mismatching are to be avoided.

Development Factors

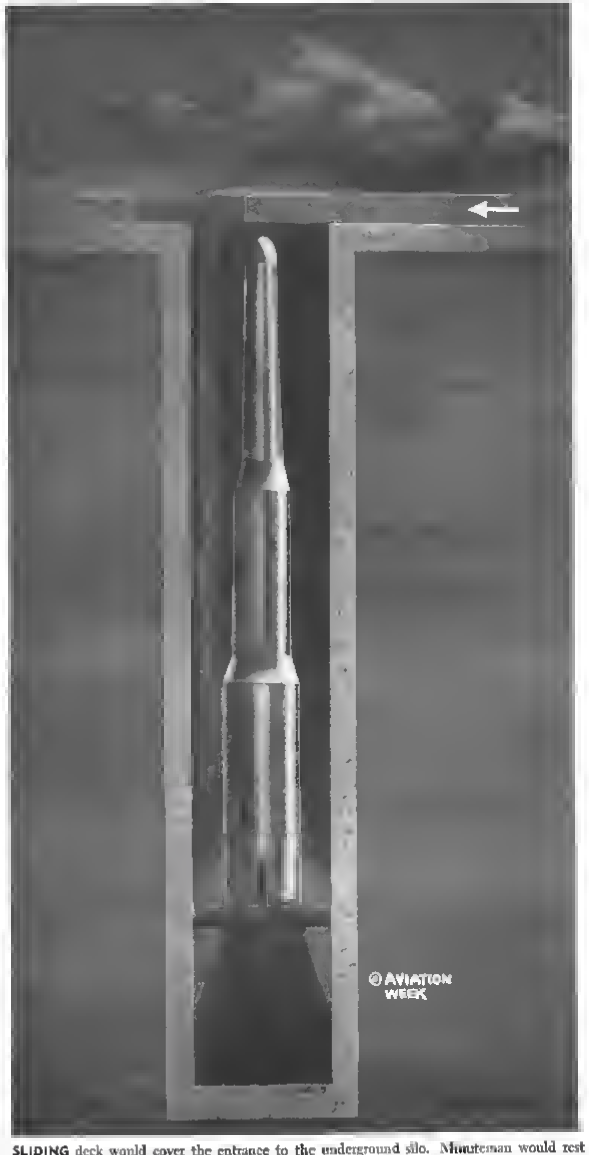
Development of ground environment will involve such factors as:

- **Assembly and test facilities**
- **Logistics.**
- **Silo design.**
- **Features to accommodate missile-silo interaction effects.**
- **Miscellaneous installations.**
- **Link system, involving functions related to command, communications, display, control, etc.**
- **Checkout, maintenance, and training.**

Ability to push development in these and other related areas will, of course, depend on financial support Minuteman is given. Not yet on a national priority basis, program nevertheless is top priority effort of the Ballistic Missile Division. Initially, about $259 million was supposed to have been tagged for the program, but only about $59 million was funneled into the effort. Indications are that more money is soon scheduled for the program—perhaps $90 million. This funding would apply to component and subsystem development, since BMD has had no "go-ahead" for the operational missile.

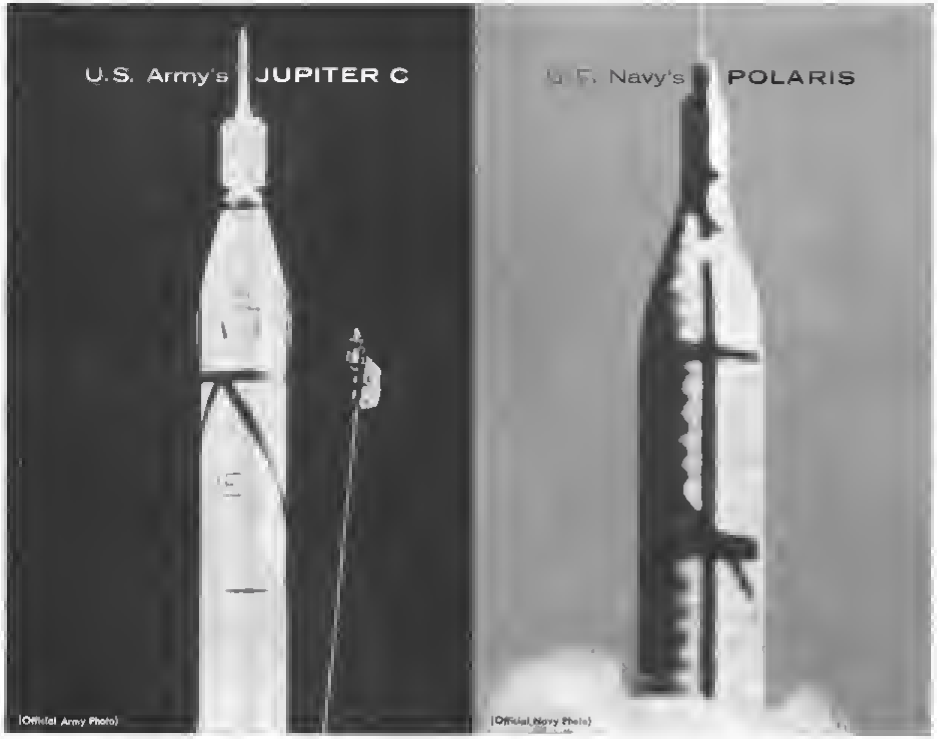
Minuteman is being advanced as a production engineering design, putting it on the same basis as other Air Force ballistic missiles. This means that Minuteman makeup will approximate the operational missile from the start. This approach is in keeping with the philosophy that many missile flight tests are not economically feasible and that when the missile is initially fired, about 90% of its makeup will comprise operational-type units. Operational "bugs" become fix' problems but these are less of a headache than simulating the design, then sifting and applying a mass of test data to achieve the final design.

Minuteman project contemplates only one basic version of the solid-propellant missile—three-stage configuration. Idea originally was circulated that Minuteman would embody the "Tinker Toy" concept—that it could serve as a two-stage intermediate range ballistic missile, and by the relatively



SLIDING deck would cover the entrance to the underground silo. Minuteman would rest on resilient supports in the silo, just above the blast pit. Missile will be about 60 to 70 ft. in length and probably will have no fins. Blast pit would be about 15 ft. deep.

Republic is the world's largest producer of Missile Metals



Many types of missile metals are required to meet the severe demands of the space age. Metals to resist heat, to reduce weight, to add strength. Production of these flight weight metals is a Republic specialty.

Stainless steel protects missiles and rockets from the searing heat of air friction. Titanium alloys offer the highest strength-to-weight ratio of any construction metal. Republic produces both of these metals in billets, hot rolled and cold finished bars, plates, sheets, and strips.

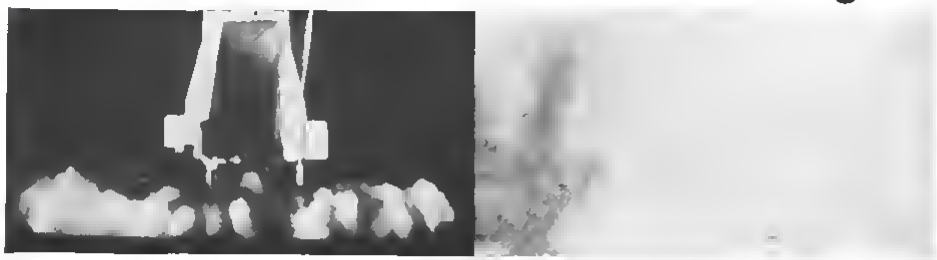
Republic Alloy Steels are continuing to play a prominent part in the development of operating and structural parts free from excess weight, yet tough and strong to withstand shock, impact, strain, and vibration.

As rapid development in the missile field increases demand for these high-strength, select formula steels, Republic is keeping pace through research and new production facilities.

Republic metallurgists and engineers will be glad to work with your personnel in developing the most advantageous use of Republic Stainless Steels, Titanium and Alloy Steels. There's no obligation. Check and mail the coupon if you would like a Republic specialist to call at your plant.

REPUBLIC'S NEW HIGH STRENGTH POWDER, TYPE HS 6460, opens the way for sinterings for highly stressed parts in aircraft and missiles. Type HS 6460 can be used with existing operating equipment. It provides a minimum tensile strength of 60,000 psi at 6.4 density as sintered, and 100,000 psi heat treated. Type HS 6460 maintains its dimensional characteristics after sintering—less than .004 inches per inch shrinkage from die size at 6.4 density. Available in production quantities up to and including 12 tons, or multiples thereof. Mail coupon for technical data sheet on Type HS 6460 Powder.

STAINLESS STEEL...for heat resistance • TITANIUM... ALLOY STEELS...for high strength



REPUBLIC STEEL

REPUBLIC STEEL CORPORATION
DEPT. AW-6298-A
1441 REPUBLIC BUILDING • CLEVELAND 1, OHIO

Have a metallurgist call.
☐ Stainless Steel ☐ Alloy Steel ☐ Titanium ☐ Iron Powder

Send more information on
☐ Stainless Steel ☐ Alloy Steel ☐ Titanium ☐ Type HS 6460 Iron Powder

Name _____ Title _____

Company _____

Address _____

City _____ Zone _____ State _____

simple process of stacking a third stage on it, convert the unit to an ICBM.

This approach is not considered feasible, was never pushed, and Minuteman will remain a basic three-stage ICBM. Minuteman will, however, achieve many of the solutions required for an advanced solid propellant IRBM, and it would be a relatively easy task to scale down Minuteman to a two-stage configuration to create an intermediate range missile.

At present state of development there is only a nominal design—a stage of development from which departure is made for the operational missile. This means that though the nominal design is an initial effort, it is nevertheless a realistic incorporation of all factors from which refinements stem to create the operational missile. If everything would check out according to expectations, the nominal design would become the operational configuration. Theoretically this is possible, but development experience is against it.

Minuteman missile is by no interpretation a limited configuration. One of the basic elements of the Minuteman system is the constant envelope concept which will permit incorporation of growth factors. Ultimate design projections will not wait until design refinements are indicated, but will allow for them initially. General Dynamics study has been completed and has considered what growth will be in the various areas of the system. As a result, Minuteman design logically is tending to be oversize and overweight, but this approach will save time and money.

Constant Upgrading

There will be a constant upgrading of operational effectiveness. Even after the design is frozen improvements in missile components will be able to be cranked into the configuration. Even handling equipment and a fixed structure such as the underground silo will be projected to accommodate missile changes.

Development work in Minuteman timetable now comprises laboratory and ground tests of components and subsystems which constitute the design elements of actual hardware. These design elements must be proved feasible to determine whether the total system is feasible.

In the solid propellant rocket engine category, initial work began as feasibility studies and have graduated into tests, which have been conducted for a considerable period of time. Design elements of the propulsion system have been checked out at Thiokol's plant in Huntsville, Ala., with very successful results. One of the units in these tests has been the largest solid propellant engine ever fired. This powerplant duplicates many of the design features of the specific engine projected for Minuteman. Though there have been no disclosures of specific characteristics evaluated, it is logical to assume that the tests have been concerned with propellant formulations, flame temperatures and specific impulse values.

Propellants undoubtedly are available which, even at this stage of development, are considered adequate to meet present specifications, but it is certain that Minuteman is counting on using better propellant formulations as they come along in the normal course of development before the missile becomes operational.

Propellant will be a cast charge. Experience indicates that differential expansion between grains and case will not present too formidable a hurdle. Charge essentially will be a "rubberized" mass—a homogeneous mixture of fuel and oxidizer plus additives to impart special properties. Key ingredients of the charge, these additives control physical characteristics, burning rates and flame temperature.

Method of thrust termination probably will be built into the solid propellant rockets, and experimental work in this field rapidly is whittling this control problem.

Despite the extensive progress which

has been made in solid propellant development, the rocket engine probably will be the longest lead time item to meet the final missile specifications. This in no way indicates a lack of optimism for progress in this field because data indicate that there are no imponderables in the propulsion development program. Size of the solid-propellant engines may, however, pose a difficult problem. Special facilities may be required for production of these huge solids.

Auxiliary power units for Minuteman missile probably will be developed along one of two alternate approaches. One scheme is to use the same type of propellant as used in the main engine, to drive a gas turbine. This method is a relatively simple approach but involves a weight penalty. Another possibility is to utilize gas bleed from the basic solid propellant rocket engine. This approach is more difficult but involves carrying less hardware, hence probably would be used if gas bleed from solid propellant burning proves feasible.

Auxiliary power units are the responsibility of the engine contractors, and no backup effort in this area is planned.

Relative Sophistication

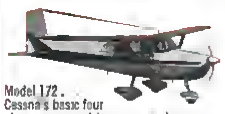
There has been considerable conjecture concerning relative sophistication of the Air Force Minuteman ICBM and Navy Polaris IRBM. Similarities exist, but Polaris might be considered an early-day version of solid propellant ballistic missile techniques which necessarily involves compromises to meet the peculiar environment of submarine operation in which the crew must live with the missile. In its present research and development configuration, Polaris doesn't equal the sophisticated projections laid down for Minuteman at this time, observers feel.

Obviously there should be considerable coordination between the two services with respect to basic solid-propellant ballistic missile progress, but neither program has moved far enough to aid the other materially. Coordination undoubtedly will become closer as designs move toward operational goals.

Sites for Minuteman launchings necessarily will be spotted in remote areas. These sites conceivably could be in various types of relatively inaccessible terrain such as desert, wooded sections or in mountain foothills. General conception of hard-launch base envisions an almost invulnerable underground silo to house the missile, but does not rule out the possibility of putting a vertical tunnel in the foothill area of a mountain which would constitute a natural "hard" site for Minuteman.

Feasibility studies already have been conducted for Minuteman sites. Various geographical areas in the U.S. have been considered to see if they

Cessna
Model 150 — two-place tricycle geared high wing airplane for training, rental, pleasure, and general utility use.



Model 172
Cessna's basic four place economical business airplane

Model 175
Offering the replacement market improved performance in an airplane of medium price.

Model 180
High performance airplane using conventional landing gear for short, rough fields and also adapted to use skis or floats.

Model 182
Tricycle geared high performance airplane of medium price.

The Skylane DeLuxe version of the Model 182, offered only as a fully equipped airplane.

Model 310C — Top of the Cessna line, adapted to the needs not only of the individual customer needing a light twin, but to those of fleet users as well. Offered as delivering the finest overall performance in the entire light twin market.

would fit the Minuteman concept, but no specific areas have yet been firmed.

Silo sites selected for Minutemen probably will accommodate only one missile so that in the event an enemy attack knocks out a site, only one unit of retaliatory potential will be effected. Separation of sites will depend upon projections of enemy attack capability—not only ability to get through defenses but also destructive capacity of delivered warhead.

Numerous schemes have been considered to coordinate Minuteman missile, manufacturing and assembly sites with launching sites, considering logistic and safety factors involved. Most feasible solution probably would be to have missile components fed into a final assembly point in a relatively remote, inaccessible geographical spot centrally located with respect to a circumscribed area of launch sites, so that missiles could be fed to a large number of use-points in much the same pattern as spokes radiate from the hub of a wheel.

Missile Transportation

Mode of transportation from final assembly to launch site probably has not yet been firmed, but because of the remoteness of Minuteman firing sites it is logical to assume that airport facilities will not be sufficiently near to permit direct airlift of missiles to the point of use, even if this were feasible from viewpoint of weight, size and safety considerations. This means that there necessarily will be some portion of transportation which would involve use of roads or rails.

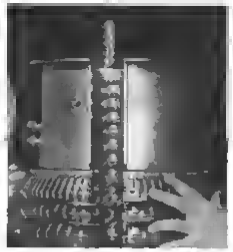
Minuteman sites probably will be unattended. This isn't because bases will be cold, inert installations, since a certain amount of environmental input will be required to maintain a readiness capability. But remoteness of sites and inherent built-in protection of silo will minimize the need for troops on guard. Also, troops would require housing and supplies. It would be desirable to eliminate need for attendance by personnel, since introduction of the human factor brings with it a reliability hazard.

Manned bases also make spotting a missile location relatively simple, although this would not be a major consideration because once an installation becomes fixed it is virtually impossible to cloak its existence. But unmanned sites necessarily introduce the requirement for complete automaticity and the ultimate in remote control, to maintain instant retaliatory capacity. All these considerations indicate the colossal ground environment job to ensure top effectiveness of the system. It's logical to assume that decoy installations also will be included, introducing an additional complexity factor.

Transportation by truck or flatcar

SOME REASONS WHY THE T58 IS EASY TO MAINTAIN

T58 is easily handled due to its low weight, small size, and unit package design of gas generator and power turbine assemblies. Major components can be disassembled with standard tools and a minimum of special equipment.



T58's split compressor-casing (left) permits easy access for changing compressor blades. Split combustor-casing (right) facilitates combustion liner inspection and fuel nozzle replacement. In the field, these operations can be performed without removing engine from the helicopter.

HOW MODERN **T58** *POWERPLANT HELPS PROVIDE . . .*

Most Payload Capacity, Highest Performance Capability

GENERAL ELECTRIC T58's GIVE NEW VERTOL 107 GREATER CAPABILITY THAN POSSIBLE WITH ANY OTHER AVAILABLE GAS TURBINE

The U.S. Army's recent announcement that it had purchased a quantity of T58-powered Vertol 107 (YHC-1) helicopters was further evidence of the growing trend to employ the General Electric T58 when seeking the powerplant which provides helicopters with highest performance capability.

What makes the T58 so attractive? Compared with other gas turbine engines in its class, the twin T58 powerplant gives the YHC-1 *at least*

18% MORE INSTALLED POWER—The T58 is guaranteed to deliver 1050 shp.

7% LOWER SPECIFIC FUEL CONSUMPTION—The T58's SFC rate is guaranteed at a low 0.64 lb/hp-hr.

300 LBS. LESS ENGINE WEIGHT, PLUS INSTALLATION WEIGHT SAVING—The compact T58 weighs only 271 lbs.

These outstanding features of the T58 make it the engine with the highest power-to-weight, lowest SFC of any turboshaft flying today—the only gas turbine now available which provides the Vertol YHC-1 with

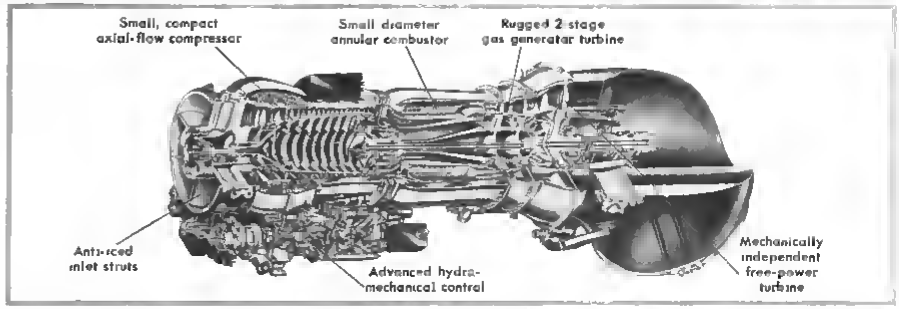
OUTSTANDING RANGE AND PAYLOAD—Light weight, high power, low SFC of T58's give YHC-1 increased range, added cargo- and passenger-carrying capability.

SUPERIOR HOT DAY AND HIGH ALTITUDE PERFORMANCE—Twin T58's have "reserve power" to operate at higher than standard temperatures and altitudes without offloading payload.

UNPARALLELED ONE-ENGINE-OUT CAPABILITY—Even with one engine inoperative, YHC-1 will still be able to continue missions with the power available from a single T58.

In addition to these operating advantages, T58's are designed for fast and easy maintenance, minimizing helicopter "down-time." When T58-powered Vertol YHC-1's are delivered, they'll give the U.S. Army a full-time airborne mobility never before possible with rotary-wing transports.

For new brochure, "What Does Engine Weight Mean in Dollars To Helicopter Operators," write to General Electric Co., Section 233-19, Schenectady 5, N. Y.



General Electric T58's near 4 to 1 power-to-weight ratio, 0.64 SFC assure top helicopter performance. Modern aircraft gas turbine design principles and development techniques incorporated in the T58 result in proven ruggedness, reliability. T58 gas turbine state-of-the-art provides helicopter designer and operator with a powerplant with "years ahead" ability.

Progress Is Our Most Important Product

GENERAL ELECTRIC

from a final assembly point centrally located with respect to an extensive region of launch sites will pose considerable hurdles. For a three-stage solid propellant configuration, Minuteman missile may attain a length up to 70 ft. Solid makeup would introduce considerable weight, so that the missile, with an alignment jig in which it would be cradled for shipment, together with supplemental equipment conceivably could weigh well over 100,000 lb. This would introduce problems never before associated with axle and wheel loads, tire pressures, roadbed and bridge strengths.

High-energy solid-propellant which would muscle the Minuteman would fall into the category of a Class 9 explosive, introducing a hazardous situation for highway, rail or air transportation. Class 9 explosive—a shipping classification—is the most hazardous of all explosive categories, and includes practically all military explosives, such as most of missile solid propellants: TNT, dynamite, RDX and PETN.

Indications are that the physics of detonation of some of these propellants are relatively unknown quantities—an area in which considerable work is yet to be done. Physical behavior of the Minuteman propellant probably would be considered touchy under conditions of normal transportation and it is even probable that special cushioning and controlled-temperature provisions will be incorporated in the carrier. Another sensitive factor is transportation of a nuclear warhead, probably under Atomic Energy Commission control.

Silo Housing

Silo housing for a Minuteman missile hard base would involve a large number of related problems which, though capable of solution, would involve considerable complexity in order to obtain the extremely simple and economic operational capability envisioned for the solid-propellant ICBM. In addition to normal engineering hurdles, the big consideration will be to make silo construction as inexpensive as possible because of the very large number of sites likely to be spotted across the nation. It is almost certain that a crude brick-and-mortar or massive concrete installation will not be feasible from both strength and cost viewpoints.

First question which arises is, how hard is hard? Degree of hardness built into the base will be dictated not only by economic considerations but by capability projected for a potential enemy as well, considering the state of the art which likely will exist at the time Minuteman becomes an operational system.

Analysis necessarily indicates the need to protect the entire installation, including the most delicate equipment and even most insignificant piece of hardware, which must be assumed essential to operational success or else it wouldn't be there. Indication of the protection problem involved in hardening a base, is that a direct hit with a 20-megaton warhead might scoop a hole 300 ft. deep with a rupture of earth underneath of another 800 ft. Even decking the underground silo might involve a huge blast resistant mass of material, since a bomb of today's capability might lift a big slab of concrete at a fairly large distance from ground zero.

In addition to protecting against physical effects of blast, precautions may be required against other bomb damage potential such as effects of nuclear radiation on missile components, indicating the degree of refinement planning involved in preparing for an effective system of retaliation.

Minuteman missile probably will blast out of the silo much like a shell from a cannon. Silo structural integrity and accurate launch capability will have to be provided to withstand the huge exhaust pressure, acoustic vibration and heat effects involved in first few seconds of missile lightoff in the pit. Acoustic vibration probably will be the most serious hazard.

Silo design to take care of these factors will require unusual treatment. One approach might be to provide a silo sufficiently deep for the pocket beneath

the missile to take the blast vibration and heat of exhaust to minimize interaction effects between silo walls and missile itself, because of the danger of damage to missile skin and components. Another approach would be use of exhaust trunch leading from the pit below the missile to the surface to ensure fast bleed-off of pressure and heat of exhaust.

Personnel from Air Force's Ballistic Missile Division also have been evaluating, with rough experiments, the feasibility of the silo environment for solid propellant rocket firings. These tests, conducted at Edwards AFB, Calif., have utilized concrete pits (silos) instrumented along the walls to record blast and heat effects during rocket liftouts. These runs do not reach approximate conditions which would be involved in actual Minuteman firings but serve to produce basic data which can be interpreted to indicate the order of magnitude of the launch phenomena involved.

Maintenance Factors

Maintenance aspects of the missile as it sits in its hole, with its guidance preset and running slowly, with gimbals locked, will be a very critical factor. The situation may be compared to a very accurate, very sensitive watch with its spring wound but unreleased, in a hostile environment. Silos or other installations housing the missile will require precise temperature and humidity control to ensure an even atmospheric environment exists regardless of external weather conditions, so that missile components can retain the designed reliability for instant readiness.

Proper atmospheric environment in the silo probably also will be a decisive factor in controlling propellant's effective life as missile sits in its underground shell.

Propellant will age, and if it does not have required physical and chemical characteristics, the missile will be as ineffective as if some other system component performed at only a fraction of its efficiency.

Even under most favorable conditions, propellant (and other system components, as well) will have a storability limit which will impose a burdensome maintenance requirement on the over-all system plan. Since it will not be feasible to accomplish replacement of individual rocket stages, or most other components, in the silo or above ground at the remote site, the missile as an entire unit will be pulled from the hole and replaced with a fresh unit.

This will be done on a constant rotation basis at an interval which probably will be determined by the life of the solid propellant. This may run as

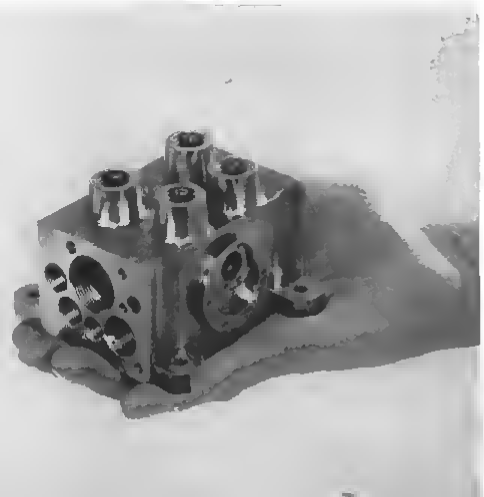
How Titanium licks the weight bogey in components . . . A STUDY IN MACHINING SUCCESS

Today's aircraft component manufacturers are getting squeezed from two directions: Weight allowances of complex parts are being drastically reduced . . . but redesign costs to shave off a few ounces of excess "fat" cannot be written off in the short-run orders of the current market.

What can the manufacturer do? Should he trade profit for good will, or should he simply give up, and yield his position in a market with such excellent potential?

Titanium Metals Corporation of America has found increasing case-history evidence that an economically sound compromise exists: Substitution of titanium for heavier materials, on a volume basis. The results: a lighter assembly; elimination of redesign costs; and no extensive equipment purchase or modification

Best news of all, the finished product can be marketed competitively. Here's the proof:



There's an old chestnut, held over from several years ago, that titanium is next to impossible to machine. This belief goes back to the time when fabricating techniques for this new material were still being developed. Today, though, the picture has changed:

". . . prefer machining titanium to . . . stainless steel . . ."

Cadillac Gage Company, Warren, Michigan, has substituted Ti-75A titanium for a high-nickel alloy in valve housings designed for North American Aviation's A3J Navy attack aircraft.

Titanium *combines* the properties that ordinarily require a series of materials. Lightweight titanium is non-magnetic, corrosion-resistant and retains its great strengths from −300°F to +1000°F. What does titanium mean to Cadillac Gage in production of valve housings?

Weight saving: 2½ lb. Size of contract: $100,000.

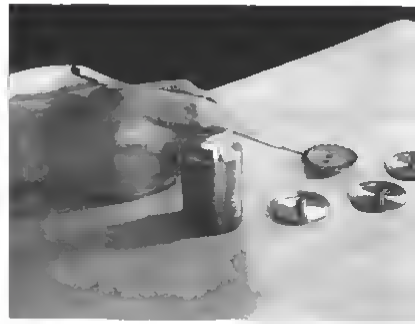
Project Engineer Robert Moffatt states. "Our shop personnel actually prefer machining titanium to some grades of stainless steel. And the use of titanium has added no more than 5% to 10% to the final cost of the valve."

". . . ease in machining . . . competitive with plastics . . ."

Fischer Machine Company, Philadelphia, Pennsylvania, machines titanium on conventional equipment, holds tolerances to 0.0002" on ½ ounce turbine wheel 1¾" in diameter, has contracts for $60,000 in titanium parts.

The turbine wheel, which actuates the generator in Philco's 155-pound Sidewinder missile, reaches speeds of 60,000 rpm in a fraction of a second. The application calls for a low density material with great strength and heat resistance. Fischer employs annealed Ti-6Al-4V (130,000 psi tensile, density 0.163 lb/cu. in.) for the job.

General Manager John Sutton says: "Recent price reductions and our ease in machining have combined to make the prices of our turbine wheels competitive with machined plastic wheels. There is, of course, a price difference — but that's more than settled by titanium's vastly superior performance."

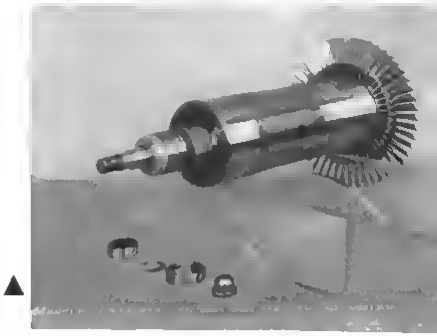


. . . titanium helps hold rotor weight to 20 pounds . . .

General Electric Company, Lynn, Massachusetts, has introduced a new concept in electrical power generation which combines the generator and turbine into a single self-cooling unit. It's called the Turbonator.

Turbine and rotor — both on a common shaft — operate at 24,000 rpm. Titanium substituted for steel in top sticks and retaining rings enables GE to hold rotor weight to 20 pounds, and achieve efficient turbine speeds, because non magnetic titanium can withstand high centrifugal forces.

John W. Harrison, project engineer, reports: "The Turbonator cuts package size 50% and cost 20% from conventional turbine-generator systems. It's versatile and can be used anywhere there's a jet engine."



These findings highlight two things: the growing concern of airframe makers over weights of purchased parts; the feasibility of constructing with titanium, instead of redesigning to combat excess weight.

The key to effective use of titanium lies in overcoming ingrown fears relative to machining.

For example, titanium has a low work hardening rate, low coefficient of friction, low shearing force and freedom from notch sensitivity — all contributing to its relatively good machinability.

Commercially-pure grades (Ti 55A, Ti 65A, Ti 75A) in general, machine similar to the 300 series of stainless steel. Alloy grades (Ti-6Al-4V, Ti-7Al-4Mo, Ti 155A, Ti-5Al-2.5Sn) are similar to the 400 series.

Use of sharp tools (replaced at first signs of wear), high feeds, slow speeds, and liberal amounts of coolant enable fabricators to achieve economical production runs.

Titanium Metals Corporation of America is always ready to help you take full advantage of titanium's excellent combination of design properties, by providing a steady flow of information on fabrication techniques, and maintaining a referral program by which prime contractors may locate component manufacturers of demonstrated ability.

Entrance into titanium now can mean immediate contracts and establish your firm in the long term future. Contact the TMCA sales office in the city nearest you for further information on how titanium can help you.

TIMET®

TITANIUM METALS CORPORATION OF AMERICA

233 Broadway, New York 7, N. Y.

SALES OFFICES: NEW YORK
CLEVELAND • CHICAGO • DALLAS • LOS ANGELES

high as three years, depending on propellant development. This means that all other components probably will be designed to have a reliability span at least equivalent to this interchange interval.

Procedure for pulling of the "dated" missile and substitution of another for it in the hole, all poised and ready to go, will probably be streamlined to be done in a fraction of a day so that total effectiveness of the retaliation force will be cut for only a short period of time.

Even though the servicing scheme will provide for substitution of the complete missile, it's logical to assume that some preventive maintenance will be applicable to some of the installations on a periodic basis, such as pulling one black box of a specific type and substituting another, merely to 'play it safe.' This is because, even though definite deterioration time standards will be established for these components, a check on this "average life time" might still be considered mandatory to ensure an "always-ready" status.

Site Responsibility

Considering the efficiency demonstrated by commercial organizations in the field of maintenance, it may develop that the assembly and test contractor or some other commercial organization will be given responsibility for missile replacement, maintenance, inspection of parts and return to the original manufacturer for servicing.

Unlike the Atlas and Titan ICBMs and Thor IRBM, which will have attendants around the clock at the operational site, the unattended Minuteman silo at its remote location may even have a built-in interrogation system to ensure an always-ready status for the missile. This type of system, to be of utmost effectiveness in checking out a poised-to-fire weapon, probably should not only give a "go" or "no go" answer, but incorporate as well, the capability of indicating the specific trouble. It would only be a matter of engineering refinement as to how far into the system the trouble shooting capability could reach. Activated from and displaying its answer at, a remote manned control station which might have a multiplicity of sites under its buttons, this type of interrogation system would be tremendously expensive but not incapable of being included in a master plan for the entire Minuteman system, since this plan has not been formulated in detail to reveal all the ramifications for an instantly ready deterrent system.

Analyzing the paradoxical situation of the enormous system complexities involved in achieving the basic simplicity of the unattended, pushbutton fired Minuteman, it may be logical to

assume that, if the road-bridge-truck problem of transporting the heavy missile is solved, planners might consider a completely mobile capability for the missile. In this scheme, the missile conceivably would be fired directly from the transporter (truck or flatcar).

Advantage would be that the weapon would be less vulnerable to enemy pinpoint attack because of its mobility, since the transporter would change its location periodically. Crew which would be operating the truck (or flatcar) would have assurance that the missile always would be under surveillance, and perhaps some additional reliability would be cranked into the system if this crew were equipped to perform a reasonable amount of black box servicing.

If this mobile launch scheme were implemented at all, it is likely that it would be used to supplement the basic fixed base (silo) plan, so that the nation's retaliatory capacity would not present, to an enemy, a series of fixed targets. From the most advantageous economic viewpoint, this combination of fixed and mobile units might encompass a minimum number of missiles sitting in silos, supplemented by a minimum of "traveling missiles" whose number could be increased, depending on the state of emergency.

Probably the most vital, and most difficult aspect of the ground environment will be the launch control system. This undoubtedly will involve both the site control centers—one for each missile or group of missiles—and a command or master control station. This function probably would have sole launch authority, necessarily would have such control that no site control center could initiate firing without concurrence of the command station.

Obviously, the site and command control stations, because of their critical functions, could not depend on conventional communication links already in existence, but would require special communication schemes or circuits, unusual protection to minimize vulnerability and opportunity for jamming and sabotage. Also, control centers themselves, like the missile emplacements, would have to be "hard" installations—harder than the missile site itself—since they would trigger the launch, and even if the site control station could not function, the command station, with its independent launch capability, would still have retaliatory power.

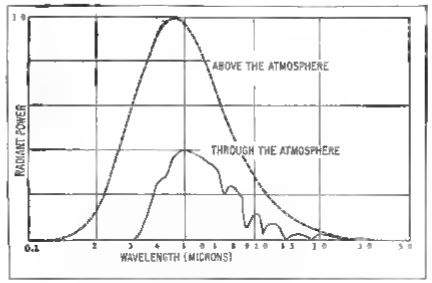
It's likely that the command function would be duplicated to ensure backup capability if prime command station could not operate.

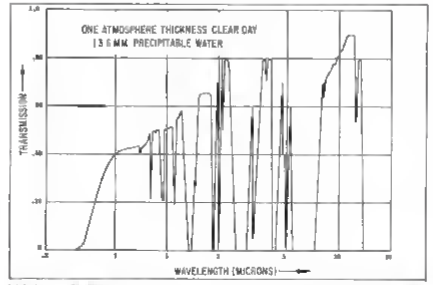
Other possibilities present themselves. The command control station might be mobile to avoid giving a fix on its location. The mobile station might be earthbound or airborne.

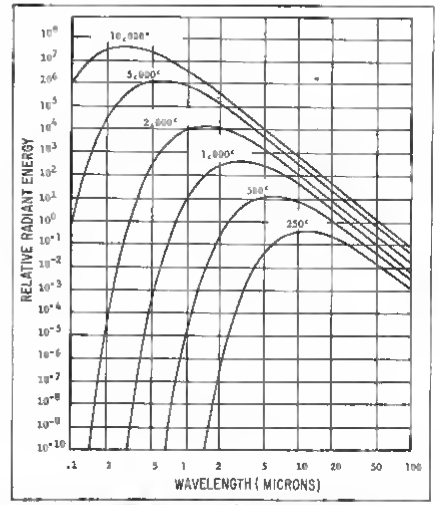
If connecting link were by radio, it could be jammed. In an airborne control station, a narrow electromagnetic beam (pencil beam) could be used. To jam this, it would be necessary to get into the beam or use an exorbitant amount of jamming power because directional transmitters and receivers would be employed.

Missile Squadron Emblem

Air Force has approved use of this emblem by the 864th Strategic Missile Squadron now training for operation of Jupiter intermediate ballistic missile at Redstone Arsenal.







SOLAR radiation spectrum (upper left) outside the atmosphere is indicated by dotted line, at the earth's surface by solid line. Transmission spectrum of the atmosphere under typical clear day conditions is shown at bottom left. Planck's equation, which is used to calculate the radiation emitted by a black body as a function of wavelength, is plotted for various temperatures at right

Satellite Reconnaissance Optics (Part I):

Earth Radiance Affects Image Contrast

By James A. Fusca

Clifton, N. J.—Because all parts of the earth can be observed by a satellite in a polar orbit, the development of reconnaissance systems capable of gathering data by television, infrared, photography and similar techniques presently is receiving very high priority in the U. S. satellite program.

The two most immediate uses of satellite reconnaissance systems appear to be for obtaining military intelligence on the installations and activities of potential enemies and for meteorological survey of the earth's cloud cover for more accurate and world-wide predictions of weather.

These two applications also represent extremes of technical performance of image detecting devices because while the requirements for meteorological observation of cloud cover might be satisfied by a picture resolution measuring no better than a mile or more on the ground, the requirements for military usage demand extremely fine picture detail.

Because of the demands of reconnaissance systems now under study and the probable broad spectrum of future reconnaissance satellite applications as well as the rapidly changing state of the art, the Space Reconnaissance Laboratory at Allen B. Du Mont Laboratories has prepared a study report which it states is designed to consider the fundamental processes and limitations which apply to all satellite reconnaissance systems.

The report titled "Fundamental Considerations of Reconnaissance From a Satellite," is the result of the work of 10 scientists and engineers of the Space Reconnaissance Laboratory. Three of the subjects considered are of immediate interest in describing the physical limitations inherent in any reconnaissance system employing image detecting devices.

Physical Limitations

Optical problems affecting earth reconnaissance from a satellite can be divided into three general categories: earth radiance, atmospheric optics and optical resolution limits.

- **Earth radiance** concerns the optical properties of the radiation coming from objects on earth and earth itself.
- **Atmospheric optics** concerns the degradation of the optical image by the intervening atmosphere between the earth and the satellite.
- **Optical resolution limits** concerns the image-forming properties of the optical system in the satellite.

Each problem makes up one link in the optical communication system transmitting optical information from the earth to the satellite. The overall result is obtained by cascading the properties of each of these links in series.

The first of these problem areas, earth radiance, is concerned with radiant energy emitted by the earth from three major sources:

- **Solar reflection.**
- **Solar irradiation.**
- **Artificial radiation.**

By far the most important source of radiant energy is the sun. During daylight hours this energy, as modulated by the spectral reflection characteristics of a wide variety of targets, provides the most intense object radiance. This energy spectrum peaks in the visual region.

In addition to the direct reflection of sunlight, part of this solar energy is

absorbed and reradiated in the infrared region as heat, from about 5 to 40 microns and peaking at about 12 microns. This radiation is essentially constant day or night and provides a uniform background blanketing the earth.

In addition to both the direct and indirect radiation from the sun is the radiation from artificial sources. In general, these sources are associated with human activity, the most important class of artificial radiation sources being heat engines of various types. Such objects might range from a tank to a steel mill or the exhaust blast generated by the launching of an intercontinental ballistic missile.

Any object with a temperature above absolute zero emits energy over a wide band of frequencies. Most of this radiation is emitted near a specific wavelength which is dependent upon the temperature of the object.

Calculations to determine the various characteristics of radiation, whether in the ultraviolet, visual, or infrared region, are based upon three physical laws, each of which has been thoroughly discussed in the literature. These fundamental relationships are:

- **Stefan Boltzmann law** which gives the total radiation from an object.
- **Wien's displacement law** which gives the wavelength for maximum radiation at any specified temperature.
- **Planck's equation** which gives the radiation emitted by a black body as a function of wavelength.

Each of these laws makes use of the concept of black body radiation defined as the radiation emitted by an object which absorbs all incident radiation without reflection. Such radiation is greater in total energy than that emitted by any other type of material at the same temperature.

Since physical objects do not meet the requirements of an ideal black body, an emissivity factor must be used to correct for the surface characteristics of the emitter. The emissivity factor varies with the material and ranges from 0.02 for a silver mirror surface to 0.95 for lampblack. For certain non-metallic materials such as carbon, the emissivity varies only slightly with wavelength, but with many materials it decreases markedly in the infrared region.

The radiance of any point on the earth is determined by the product of the illumination on the object and the reflectance of the object. In turn, the illumination available is determined by the radiation from the sun as modified by its passage through the atmosphere and the angle it makes with the surface of the object. This angle is determined by the time of day, the latitude and the season.

The sun radiates very nearly as a

Earth Surface Reflectance

SURFACE	ALBEDO
Fresh snow	80
Old snow	.40 approx
Grass	10-23
Rock	12-15
Dry earth	14
Wet earth	08-09
Water (sea)	.03-10
Forest	05
Deserts	25
Cloud sea	50-75

black body having a temperature of 6,500 deg. Kelvin. This spectrum of radiation is modified by the transmission characteristics of the atmosphere during passage to the earth.

In photometric units, a generally accepted figure for the illumination received outside the atmosphere from the sun is 13,600 lumens per square foot. Another more common name for this unit is the foot-candle. In terms of heat the corresponding solar constant is about 1.94 calories per minute per square centimeter.

Energy Absorption

The absorption of radiant energy in the atmosphere comes largely from fairly intense absorption bands of water vapor, carbon dioxide, and ozone. The ozone absorption is relatively constant and exists at very high altitudes but the amount of water vapor varies greatly with atmospheric conditions. For this reason, it is usual to specify the total water content of a vertical path through the atmosphere from ground level to the end of the atmosphere. A thickness of one "standard atmosphere" corresponding to clear day conditions contains about 17.6 mm. of precipitable water.

Atmospheric transmission follows an exponential law: that is, if the sunlight travels through two thicknesses of atmosphere, it is necessary to square the calculated transmission values. This would occur, for example, with the sun at an angle of 60 deg. from the zenith.

It is apparent therefore, that the amount of energy transmitted to the earth varies greatly with the altitude of the sun above the horizon which determines the thickness of the atmosphere through which the light must travel.

The amount of precipitable water in the atmosphere increases greatly with fog and cloud conditions. This, of course, is the reason that illumination drops so drastically in cloudy weather. Studies indicate, for example, that an average cloud 300 meters thick has a transmission of only 10%.

The illumination at the earth is the sum of light from two directions—sunlight and skylight. Sunlight is the light transmitted directly from the sun by

the atmosphere while skylight comes from the light scattered in the atmosphere. Daylight is considered to be the sum of sunlight and skylight. Daylight is the value of illumination usually measured at the earth.

On a typical clear day, daylight illumination has a maximum value at noon of about 10,000 foot-candles of which 8,000 foot-candles are sunlight and 2,000 foot-candles are skylight. Considering daylight as white, sunlight is slightly yellowish while the diffuse skylight, which comes nearly equally from the whole hemisphere of the sky and therefore provides illumination in shadow areas, is the color of the blue sky.

From the standpoint of satellite reconnaissance, however, it is only under "bright sun" conditions that it will be consistently possible to see objects clearly on the earth. As defined by manufacturers of photographic film this would mean an illumination value of 8,000 foot-candles. For hazy sun conditions (4,000 foot-candles), the contrast attenuation due to scattering may be so bad that the resultant signal to-noise ratio will not permit detection.

The problem of contrast attenuation is discussed under the heading "atmospheric optics" but at this point it should be noted that there will be many cases where ample illumination exists on earth for image detection by a wide variety of optical transducers if the earth is viewed from rather low altitudes where it will be insufficient for viewing from a satellite. This is one of the essential differences between optical engineering of a reconnaissance system for a low-flying vehicle and for a satellite.

Even for clear day conditions the illumination on a horizontal plane at the earth obviously will be determined by the time of day, time of year, and latitude. These factors together specify the position of the sun relative to the horizontal plane. Therefore, by applying the cosecant law to calculate the transmission through the atmosphere and using conventional photometric laws at the earth's surface, the clear-day illumination can be computed for any location on the earth at any hour of any day of the year.

When radiation falls on any body it is divided three ways. Part is transmitted, part reflected, and the remainder absorbed. The earth does not transmit energy; therefore all of the incident energy is either reflected or absorbed.

Using the foot candle as the unit of illumination, the corresponding unit of brightness of the reflecting surface is the foot-lambert. The value of brightness in this unit is obtained by multiplying the number of foot-candles falling on the surface by the reflectance of the surface. For diffusely reflecting surfaces the reflectance is a dimensionless number ranging from 0 to 1.

Therefore, if the illumination is 10,000 foot-candles and the reflectance is 0.1, the brightness is 1,000 foot-lamberts. It is the value of brightness that determines the amount of light collected by the optical imaging system.

A considerable portion of the solar radiation that falls upon the earth is reflected. Water, snow, and especially clouds are the best reflectors of solar radiation. The ground and dust in air reflect less radiation, and pure air almost none.

Radiation Data Analysis

Detailed analysis of radiation data recorded from more than 6,000 passes by Explorer satellites, a painstaking process expected to take many months, is getting under way at University of Iowa's Physics Department, under direction of Dr. James Van Allen. Carl McIlwain, one of Van Allen's associates, is shown removing one of the magnetic tapes from "library," preparatory to transcribing it into form of curves for visual analysis.

Tapered Aperture Horn Antenna

New tapered aperture horn antenna, called TAHA for short, for long-range high frequency (HF) communications, has greatly suppressed side lobe radiation better than 20 db below main beam. TAHA antenna requires no tuned elements, phasing controls or amplitude adjustments and can handle super-power transmitters. Idea of antenna size can be gained from vehicle at lower right. The antenna was designed by Developmental Engineering Corp., Washington, D. C., under Army Signal Corps sponsorship.

As seen from space the earth would appear as a very bright body surrounded by a bluish veil which is the color of the blue sky. This brightness is strong enough to illuminate the dark portion of the new moon and from this phenomenon astronomers have been able to calculate the average reflectance or "albedo" of the earth.

The albedo of the earth varies with the amount of cloud cover and also the nature of the earth's surface. For this reason there are significant seasonal variations depending on what part of the earth's disk is viewed.

The albedos of various surfaces of the earth cover a considerable range. Unfortunately, there is little information on the spectral reflectivity of these surfaces, however, for many materials such as vegetables the reflectance rises rapidly in the near infrared region.

The reflectance of water depends on its roughness. Practically no radiation is reflected by a smooth surface for solar zenith angles less than 40 deg. The albedo then increases from 0.02 at 43 deg to about 0.40 at 85 deg. The reflectance of clouds varies with cloud thickness, type, and water content. It is essentially constant to at least 3 microns.

From the astronomical earth-shine measurements and also from estimates based on the individual albedos of the ground, sea, forest, snow and clouds the results agree on a seasonal variation in average albedo of 0.32 to 0.52. A mean value of 0.45 is often quoted. The actual albedo is strongly affected by the cloud cover.

Since the incident illumination on the earth above the atmosphere is 13,600 foot-candles the average brightness of the earth with the sun directly overhead is about 6,000 foot-lamberts.

Ground Contrast

Of particular interest for both airborne and satellite-carried reconnaissance systems is the contrast of fine detail in the ground resolution, that is the frequency of occurrence of brightness differences in small detail at about the resolution limit of the reconnaissance system. Available data shows surprisingly low values for this detail modulation.

One photo reconnaissance study discussed in the literature that was made at an altitude of 4,000 ft — an altitude chosen to give an intermediate effect from the unavoidable haze present on a clear day — indicates this clearly. The ground resolution was about 5 ft. While the studs showed a wide range of contrast values, a statistical analysis showed that 95% of all targets had a contrast below 0.20 and 90% were below 0.10.

Higher altitudes and poorer weather conditions would further worsen the contrast values. This situation seriously worsens the signal-to-noise problem in many optical transducing devices.

Some of the solar radiation is absorbed by the atmosphere. The effects of this absorption are to minimize the air

26th ANNUAL INVENTORY OF AIRPOWER ISSUE

PUBLISHING DATE: MARCH 9, 1959

In twelve swift paced months, aviation's galloping technology has made dramatic breakthroughs in all areas of flight. Commercial jet transportation became a reality. Corporate fleets can now pick from a number of turbo jet or prop jet aircraft. An ICBM has flown successfully over its full range of capability. Aircraft flying at twice the speed of sound are now operational with the USAF. Larger and more complicated satellites were hurled around the globe. Actual attempts were made to orbit the moon. Space Technology has excited the imagination of the entire industry.

Event followed event with such rapidity that interpreting their significance has been difficult for even the most well informed engineering management men. Once again, they need a concise, penetrating analysis and forecast of world airpower.

ONLY ONE SOURCE FOR THE ANSWERS

Industry's decision makers, turn to the industry's top reporting team—AVIATION WEEK's 32-man editorial staff of graduate engineers and aviation specialists. . . The men whose full time job is to ferret out and report world aviation events. In the Inventory Issue, they will bring into focus the significance of hundreds of technological and marketing developments witnessed in 1958 and interpret their impact on future technological growth.

CONTENTS OF THE INVENTORY ISSUE

Charts, graphs, tables, specifications will cover in detail, budgets, missiles, manufacturing, engineering, avionics and many more areas of military and civil aviation. The Inventory Issue has been relied on for 25 years as the only complete authoritative source for detailed specifications on U.S. and foreign aircraft, missiles, helicopters and now space vehicles.

YOU BELONG IN THE INVENTORY ISSUE

Over 70,000 key engineering management men, decision makers in the industry, are eagerly awaiting this important issue. They will read. . . study. . . and refer to the Inventory Issue throughout the year. Here is a rare opportunity to place your sales message in a climate of proven editorial impact. Because of its long use life, you get as a bonus MULTIPLE EXPOSURE of your sales message. In addition, a reader service card is included to facilitate the handling of thousands of inquiries generated by this important issue.

For additional information on this once-a year opportunity . . . write, wire or better yet phone your AVIATION WEEK district office. Regular space rates apply.

Aviation Week
Including Space Technology

ABP ABC ABC JUNE 1958, 69,726

A McGRAW-HILL PUBLICATION, 330 WEST 42nd ST., NEW YORK 36, N. Y.

and to lessen the amount of energy passing through to be absorbed by the earth

The different constituents of the atmosphere do not absorb the radiation equally well Oxygen, carbon dioxide, water vapor, and ozone are the best absorbers They are moderately selective in their absorption characteristics

The surface of the earth has a mean temperature of about 287 deg Kelvin For a number of reasons, however the effective radiating temperature of the earth as observed outside the atmosphere is somewhat lower The black body radiation curve for 287 deg Kelvin is readily calculated and the absorption curves for the gases previously noted can be calculated

The remaining radiation would be that which passes through the atmosphere and escapes into space The earth, however, is not a black body radiator. Just how near it is to being one is not known, so values of the escaping radiation deduced in this manner are bound to give values for the effective temperature that are too high

The net result is a gain in energy by the "greenhouse effect." Water vapor, carbon dioxide, and ozone are much more transparent to the shorter wavelengths coming from the sun than they are to the longer wavelength radiation passing from the earth In this manner much of the radiant energy is trapped or absorbed by the air and the effective black body temperature of the earth as a radiator into space is considerably reduced This effective temperature has been calculated as 252 deg Kelvin

Although many artificial sources emit a considerable amount of radiant energy in the visible spectrum, probably the most important component of artificial radiation is in the infrared Since temperatures approaching that of the sun are seldom found in artificial sources, the spectrum of the artificial radiation is shifted towards the infrared in accordance with Wien's displacement law As a consequence, artificial radiation may generally be distinguished from reflected sunlight by its spectral distribution

The intensity of radiation from artificial sources can readily be calculated from the radiation laws mentioned, if values can be assigned to size, temperature, and emissivity of the source Such sources as industrial installations may show temperatures as much as several hundred degrees above ambient on smokestacks and similar surfaces with emissivities near unity.

A large missile exhaust, on the other hand, may be expected to have a temperature in the range of 3,000 deg Kelvin with an emissivity of perhaps 0 2 Owing to the wide range in characteristics of artificial sources, no general statements can be made as to the nature of typical values of radiance to be encountered

(This is the first of a series of three articles on the optical problems affecting earth reconnaissance from a satellite The second article will appear in next week's issue of AVIATION WEEK.)

FILTER CENTER

▶ **New Tacan Development**—New miniaturized airborne Tacan set, expected to weigh about 40 lb, is being developed by three companies International Telephone & Telegraph's Federal Division Magnavox and Stromberg Carlson, under Wright Air Development Center sponsorship Present Phase I contracts call for delivery of "brassboard" models which will be evaluated to select single contractor for subsequent design and production phases

▶ **Tacan Price Cut**—Hot Air Force competition to build improved versions of existing Tacan design, the AN/ARN 21C and AN/ARN-65, has been won by Hoffman Laboratories with price that reportedly is less than $3,000 per set, about half the former price Total contract is approximately $33 million, the largest Hoffman has ever received the company says

▶ **Transistorized DME**—Australia's Division of Radiophysics has developed transistorized version of its 200 mc distance measuring equipment which weighs only one third as much as previous tube version, occupies only half the space and consumes only one-sixth as much power Unit which has been flight tested, uses transistors throughout except for two tubes in transmitter oscillator and two thyratrons for modulators Thyratrons will be replaced with transistor modulator in subsequent models

▶ **More Heads per Inch**—New read-out head for magnetic tape recording which provides 83 separate channels per inch six to eight times the previous number possible, has been developed by Stanford Research Institute Each channel is only 0.012 in. wide, including spacing between tracks, the Institute says. New head was developed for General Electric for use in reading letters and numerals printed in magnetic ink

▶ **Space-Com Papers Available**—Collection of papers given at recent National Symposium on Extended Range and Space Communications in Washington (AW Oct 20, p 85 Nov 3, p 65) can be obtained for $2.00 per copy Proceedings can be obtained from Mr John J Renner, 1735 DeSales St N.W., Washington 6, D C

Emulsion Breaker Unit Combats Fuel Ice

By William S. Reed

Los Angeles—Emulsion breaker type jet fuel filter units will be delivered to Strategic Air Command to combat fuel system icing problems experienced in large jet bombers (AW Dec. 8, p. 27).

An initial order for a preproduction quantity of the filter units has been awarded to Permanent Filter Corp., Los Angeles, by the U. S. Air Force.

The unit is self contained and is mounted on a special vehicle. It operates at a 600 gallons per minute rate, and is placed just ahead of the aircraft in fueling sequence, i.e., between the refueling tank truck or hydrant and the aircraft's refueling receptacle.

EMULSION breaker for separating water and solid contaminants from aircraft and missile fuels is shown above. USAF has ordered the unit for use in combating jet fuel icing.

Filtering System

The company says USAF and Navy tests have demonstrated the unit's ability to remove water to a point 10 to 15 parts per million below the solution point of the fuel, and to remove other impurities such as ferric oxide down to less than ½ micron in size. The filtering system originally was developed as ground support equipment for the Thor intermediate range ballistic missile, currently is in production and use for this mission.

Units are composed of three elements or stages, with fuel entering under centrifugal pump pressure in the form of an emulsion. The first bulk contaminant removing stage consists of a circular grouping of hydrophobic nylon and glass fiber socks which cause the bulk of water to coalesce and drop from fuel stream.

A barrier follows the first filter stage, consisting of a coarse circular screen which serves to break up foam which occurs in emulsified fuel.

After passing the barrier, fuel enters the second stage, primary coalescer, a sintered bronze filter, composed of units placed horizontally in a circular group. Bronze units are approximately 20 in. long, 1½ in. in dia., with 100 units used per filtering equipment. Horizontal units have a slight tilt toward the inlet to lead water away from fuel flow direction.

Cylindrical Casing

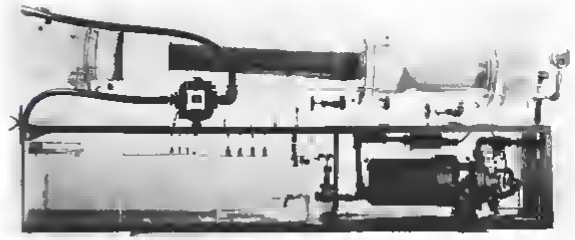
A specially fabricated cylindrical glass fiber casing completely covers the primary coalescing bronze units to become the secondary coalescing unit and the third stage.

The remaining water is stripped from the fuel as it passes through this third stage.

Called 'Perma-Dry,' units are equipped with access doors by which stored water can be removed, while filter elements can be replaced due to design—a single center post is inserted through an opening in the circular header plates—in minimum time. Use of a standby header plate makes a stop service-restart cycle of less than 30 min. possible.

Supplementary equipment includes pressure regulators, backsurge of water preventative provisions.

According to the company, a contract for production quantities of the device which is valued at approximately $20,000 per unit but varies according to equipment and spares, now is being worked out with USAF.



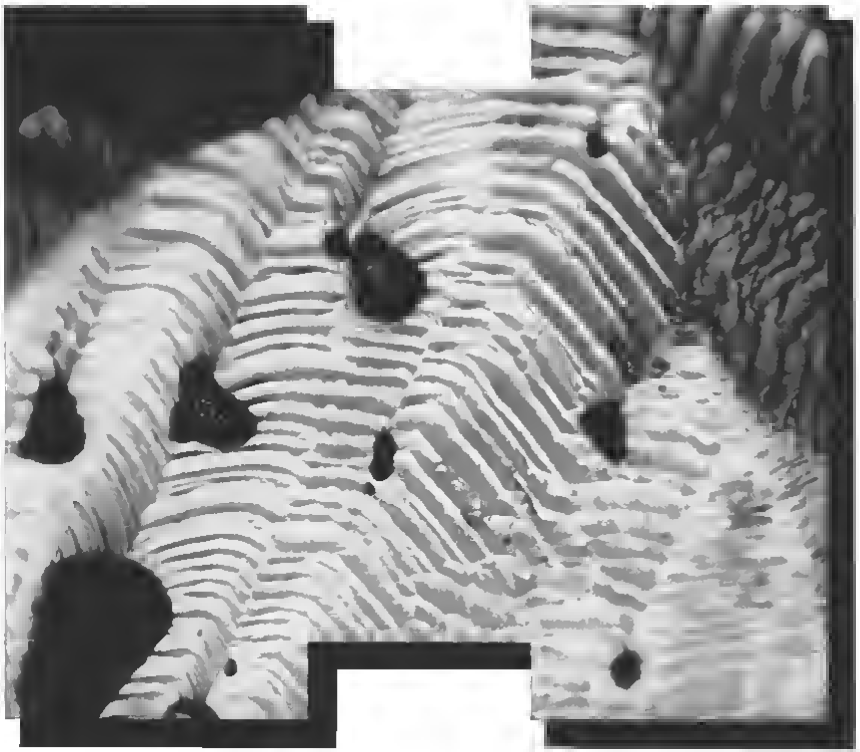
WORKING model of "Perma-Dry" unit. Fuel-water mixture enters at left, passes through a synthetic fabric to remove foreign matter. Fuel then passes through coalescing bronze unit.

Airlines to Construct Jet Engine Test Cells

Jet engine test cells are being constructed by three major airlines for the suppression of ground runup noise. Pan American World Airways will build one test cell at New York International Airport. United Air Lines will build two cells at San Francisco International Airport and Scandinavian Airlines System will build two cells at Stockholm, Sweden. Acoustical equipment for the cells will be supplied by Metals Products Division of Koppers Co., Inc., Baltimore, Md.

Cells will be of concrete construction about 95 ft. long and 50 ft. high. They will be capable of handling engines comparable in thrust to Pratt & Whitney JT3 and JT4 turbojets.

The industry that impurity built



***Exit cones** capable of withstanding temperatures of 6000° F, represent one example of advanced engineering being performed by the Hughes Plastics Laboratory*

This photomicrograph (at left) of an etched silicon crystal is used in the study of semiconductor materials. Impurities introduced into crystals such as this form junctions for semiconductor devices.

In the fast-growing semiconductor industry, Hughes Products, the commercial activity of Hughes, is leading the field. Its programs include basic research on semiconductor surfaces; alloying and diffusion techniques; and materials characterization studies to determine the electrical effects of imperfections and impurities.

In addition, Hughes Products is developing new semiconductor devices such as parametric amplifiers, high frequency performance diodes, and improved types of silicon transistors. New techniques are being devised for casting silicon into various configurations. Also underway is the development of new intermetallic compounds for use in semiconductor devices.

Other activities of Hughes provide similarly stimulating outlets for creative engineering. The Hughes Research & Development Laboratories are conducting studies in Advanced Airborne Electronics Systems, Space Vehicles, Plastics, Nuclear Electronics, Global and Spatial Communications Systems, Ballistic Missiles — and many more. Hughes in Fullerton is developing radar antennas which position beams in space by electronic rather than mechanical means.

The diversity and advanced nature of Hughes projects provides an ideal environment for the engineer or physicist interested in advancing his professional status.

Newly instituted programs at Hughes have created immediate openings for engineers experienced in the following areas

Semiconductors	Communications
Microwave & Storage Tubes	Circuit Design
Field Engineering	Systems Analysis
Microwaves	Reliability Engineering
Digital Computer Engr	Radar

Write in confidence, to Mr. Phil N. Scheid, Hughes General Offices, Bldg. 6-A1, Culver City, California

The West's leader in advanced ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY
Culver City, El Segundo, Fullerton and Los Angeles, California
Tucson, Arizona

***Falcon air-to-air guided missiles,** shown in an environmental strato chamber are being developed and manufactured by Hughes engineers in Tucson, Arizona.*

Italian Designs STOL Jet Business Plane

Geneva—First prototype of the Neeff F 400 Cobra, a jet-powered light aircraft for sport and business flying, is currently being built by Progetti Costruzioni Aeronautiche S p A—Ing Rico Neeff & Co, Milan Italy

It was designed by Stelio Frati Italian engineer who developed the Aviamilano F 14 Nibbio four seat executive transport (AW July 7, p 91)

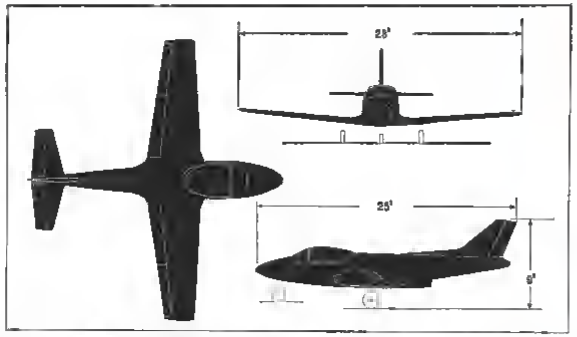
The F 400 Cobra is powered by a Turbomeca Marbore II engine of 880 lb thrust These engines are made under license in the United States by Continental Motors Corp, Muskegon, Mich

Particular design attention has been focused on short takeoff and landing performance—985 ft and 624 ft respectively—on grass strips Cruising altitude is about 15,000 ft but the aircraft can climb to approximately 25,000 ft

Using kerosene, operating cost works out to about 10 cents per kilometer (.621 mi) or $50 per flight hour including insurance and depreciation

To evaluate the cost of utilization, it is assumed that the aircraft flies 600 hr a year at cruising speed Depreciation is spread over a period of five years which results in a residual value of 16% of the original purchase price

At a cruising speed of 310 mph the Cobra covers 186,000 mi in the 600 flying hours a year Cost of the kero-



COBRA engine intakes are installed at leading edge wing roots, with exhaust pipe under the tail section. Fuselage has been reinforced with hard wood strip

sene used during that period would amount to about $16,000 Maintenance of aircraft and engine for the same period would cost about $2,200 Reserve for overhaul of airframe and engine is about $2,600 All this adds up to an annual direct operating cost of $20,800 in addition to about $6 600 for depreciation, $500 for the hangar $1,800 for insurance and $1,000 miscellaneous expenses, totaling $30 300

To offer protection in case of an emergency landing, the fuselage of the Cobra has been reinforced with a strip of hard wood, as on gliders Instrumentation, comprising VHF equipment, radio compass and night and day blind flying instruments is standard Price of this model is expected to be between $30,000 and $40,000, not more than the cost of a similar aircraft with a piston engine

With the Cobra, the newly established organization hopes to make a successful entry into the steadily growing multi purpose light aircraft market both in Europe and overseas

The owner of the new company, Rico Neeff, has already made a market survey in the United States to determine demand and to study on the spot distributors' problems and relations with prospective customers

Similar market investigations will be made in other countries where the company hopes to sell the Cobra as soon as the first series starts to come off the production line

Neeff F.400 Cobra Specifications

Wing span	28 55 ft.
Length	25 60 ft.
Height	9 18 ft.
Wing area	126 sq ft
Aspect ratio	6 5
Empty weight	1,544 lb
Two pilots	353 lb.
Fuel	925 lb.
Baggage	44 lb
Total weight	2,865 lb
Wing loading	22 7 lb /sq. ft.
Installed thrust	880 lb.
Thrust loading	3 25 lb /lb.
Maximum speed, sea level	360 mph.
Cruising speed at 13,120 ft	310 mph.
Minimum speed, flaps	65 mph.
Takeoff distance	985 ft
Landing distance	624 ft
Ceiling	31,200 ft
Range	621 mi.
Endurance at 13,120 ft	2 hr 40 min

Helicopter Survey is Precision Job

Precision helicopter survey of a river profile in northeast Canada which involved flying 400-mi with an error of 2 57 ft compared with an allowable error of 3 25 ft, was one of the major tasks handled last summer by a trio of Bell 47G-type helicopters operated by pilots of Autair Helicopter Services, Ltd, Montreal Airport, Canada

Autair estimates that to have done the mission by foot and canoe would have taken at least four years

Project was handled prior to the company's main task, which was to do a hydraulic survey covering 7,200 sq mi, using barometers, which requires clear weather with little or no wind and steady pressures Despite bad weather, the mission was completed in two months, in which time the main camp was moved four times, a total distance of 350 mi In one day the helicopters did 10 circuits covering 480 mi to obtain 108 instrument readings

Prior to returning 'home,' the helicopters transported a group of 18 mining engineers and financiers on an aerial tour of a potential mining area, covering 200 sq mi in two days After this tour, the three helicopters were disassembled in nine hours and loaded into a Douglas DC-4 for the flight to Montreal

Autair reports that its total summer helicopter activities involved six rotary wing aircraft flying some 1,500 hr in the Canadian subarctic

Spray Dust Survey Outlines Costs

Typical hourly cost of dusting or spraying crops with a two-place 150 hp airplane is approximately $28.88 on the basis of 200 hr. flying time annually or $24.14 if the same operator flies 400 hr. a year, a Department of Agriculture economist estimates.

Fixed costs of a 200-hr. per year operator are $12.06 and variable costs are $16.86, according to Melvin R. Janssen of USDA's Agricultural Research Service, who has collated his data from information furnished by agricultural applicators.

Fixed costs of $12.02 hourly include $8.36 for equipment depreciation, $1.02 for taxes, $2.04 for interest, and 60 cents for hangar rental. Variable costs include $3.75 for fuel and oil, $5 for pilot's salary, $4.15 for regular maintenance and damage, $3.50 for ground crew salaries and 46 cents for liability insurance.

On the basis of 400 hr. a year, Janssen estimates fixed costs breakdown as: $6.12 for depreciation, 51 cents for taxes, $1.02 for interest and 30 cents hangar rental. Per hour costs for variables such as fuel, oil, pilot, maintenance and damage remain the same as for a 200 hr. per year operation, he notes, but ground crew costs drop to $3 per hour and liability goes down to 29 cents an hour.

Costs per hour are translatable into costs per acre, Janssen notes, if allowances are made for variables such as ferry time between airfields, lost time from airfield to job, differences in rates of application of material such as fertilizer, pesticides or seed.

An example of an operator who dusted and sprayed 26,000 acres in Texas and had 380 hr. of plane utilization shows total per acre cost of 36.3 cents of which 24.1 cents were variable costs and 12.2 cents were fixed costs. If this same operator had covered only 13,000 acres, Janssen estimates his total costs at 42.6 cents per acre and fixed costs at 18.5 cents per acre.

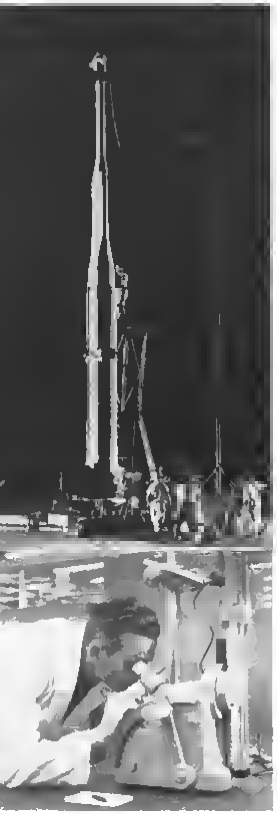
PRIVATE LINES

Vertol has been awarded a contract for $2,044,345 for six V-44A helicopters by U. S. Air Force.

New Chinese Communist-built light aircraft includes three-seat Heilunkiang No. 1 for agricultural service, made by teachers and students of Harbin Aeronautical Engineering School, stated to have top speed of 100 mph. and range of 416 mi. Landing and takeoff run are reported to be 231 ft. and payload as 484 lb. A small STOL twin-engine

(right) Checking accuracy of machine threads on a 30 inch magnification contour projector

Nation's first successful re entry tests were conducted with Lockheed X-17



Optical gauge determines measurements within 5 millionths of an inch

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

Quality assurance at Lockheed parallels in importance and augments the research and development projects, and manufacturing organizations. Quality assurance engineers establish audit points, determine functional test gear, write procedures, and perform related tests.

These activities, supported by laboratories, data analysis, establishment of standards, and issuance of reports — all insure that Lockheed products meet or surpass contractual requirements. Economy and quality are maintained at every stage to produce the best products at the least cost.

With the company holding such major, long-term projects as the Navy Polaris IRBM, Army Kingfisher, and Air Force Q-5 and X-7, quality assurance at Lockheed plays a key role in the nation's defense.

Scientists and engineers of outstanding talent and inquiring mind are invited to join us in the country's most interesting and challenging basic research and development programs. Write: Research and Development Staff, Dept. A A A-17, 962 W. El Camino Real, Sunnyvale, California, or 7701 Woodley Avenue, Van Nuys, California. For the convenience of those living in the East or Midwest, offices are maintained at Suite 745, 405 Lexington Avenue, New York 17, and at Suite 300, 840 N. Michigan Avenue, Chicago 11.

"The organization that contributed most in the past year to the advancement of the art of missiles and astronautics." NATIONAL MISSILE INDUSTRY CONFERENCE AWARD

Lockheed / MISSILE SYSTEMS DIVISION

VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA • CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO

eight passenger light transport which may be a license-built version of the Antonov An-14 Little Bee, is being produced in Peking.

Skis for use with crosswind landing gear have been developed by Federal Ski & Engineering Corp., Minneapolis, Minn. New Airglide skis are hydraulically operated so they can be raised, giving pilot option of using either wheels or skis when landing or taking off.

Downer Aircraft Industries, Inc., is new name for Northern Aircraft Inc., manufacturer of four-place Bellanca Cruisemaster and trievele-geared Bellanca 260 business planes. Company has obtained rights to manufacture Republic Aviation designed Seebee amphibian.

Production contract for 116 Hiller H-23D Raven observation type helicopters, totaling some $6 million, has been awarded by U. S. Army. Contract covers 1960 production, follows an Army award last June for 108 H-23Ds.

Sales volume of over $3.1 million is sought by Mooney Aircraft, Inc., in 1959, compared with sales of $1,702,895 in 1958. Last year's sales volume represented a 69% increase dollarwise over 1957, company noted.

New version of French Jodel, D-11C, will be built under license in Germany by Aero Flugzeugbau Hubert Zuerl, near Munich. Two-seat D-11C has a 90 hp. Continental, and gross weight increase to 1,433 lb. to provide increased baggage capacity.

American Air Taxi has inaugurated scheduled service to Marathon and Ocean Reef Key Largo from Miami International Airport.

Two-place 120-mph lightplane named the Air Tourer, is to be built by East-West Airlines, Tamworth, N. S. W., Australia, at price of approximately $6,600. A prizewinner in 1953 light aircraft design competition of England's Royal Aero Club, the Air Tourer has side-by-side seating, trievele landing gear and maximum range of 450 mi.

Grumman Gulfstream turboprop executive transport has been ordered by National Distillers, which now operates two Howard Super Venturas.

Fixed-loop antenna, less than one inch thick to provide low-drag external mounting, is scheduled for engineering release at Bendix Radio Division, Baltimore in January. Installation comprises two units: antenna and GMA-71A or 71B goniometer, the designation applying to unit specifically for business aircraft use, and having a pointer for ADF indication. Goniometer is container in three-inch instrument case.

U. S. Army took delivery of its last L-19 Bird Dog liaison airplane, a TL-19D instrument trainer. L-19, which went into production in December 1950, represented 3,259th Bird Dog Cessna will build an additional quantity for France in 1959.

New Hiller helicopters distributor is Joliet Airmotive Inc., at Joliet (Ill.) Municipal Airport.

Suburban Chicago restaurant, about a mile north of Howell Airport, is paying all landing fees for private pilots who fly in for Sunday dinner, in addition provides free surface transportation.

Two Cessna two-place Model 150s have been delivered to State College, Pa., for use in USAF ROTC flight training program. USAF is expanding its college ROTC flight program, providing private pilot's license to students, to some 170 schools in Fiscal 1959. Indications are that "wash-out" attrition rate in later training at USAF primary schools has been halved as a result of lightplane instruction in colleges.

WHO'S WHERE

(Continued from page 23)

Changes

George B. Rathman, project manager, Advanced Research Projects Agency contract for solid propellant research, Minnesota Mining & Manufacturing Co., St. Paul, Minn.

Richard E. Fisher, project manager, jet planning, Pacific Alaska Division of Pan American World Airways, Inc.

Lums Achitoff, supervisor of airport navigation standards, Aviation Planning Division, Aviation Department, The Port of New York Authority, New York, N. Y.

Robert A. Banks, director of material, Randall Engineering Corp., Los Angeles.

James M. Stone, assistant general manager, Des Moines division of Solar Aircraft Co., San Diego, Calif.

Kevin J. O'Neill, assistant plant engineer, Norden Division of United Aircraft Corp., Stamford, Conn.

Jack M. Cherne, director of engineering, Vard, Inc., Pasadena, Calif.

R. A. Rahe, general manager, Warren Wire Co.'s Western Division, Alhambra, Calif.

Joseph M. Till, production control manager, Montebello plant of Western Design, a division of U. S. Industries, Inc., Los Angeles, Calif.

John L. Gergen, director, Atmospheric Physics Division, G. T. Schjeldahl Co., Northfield, Minn.

Edward J. Flynn, West Coast representative for the newly established Los Angeles, Calif., office of Republic Aviation Corp.

Paul E. Cate, director of industrial and production engineering, Fulton Sylphon Division, Robertshaw-Fulton Control Co., Knoxville, Tenn.

F. J. Burchfield, general manager, and treasurer, and H. E. Bishop, chief engineer, Prewitt Aircraft Co., Clifton Heights, Pa.

George T. Mundorff, manager of business administration, Link Aviation, Inc., Binghamton, N. Y.

Dr. Charles Alexander Escoffery, military products manager, International Rectifier Corp., El Segundo, Calif.

Spencer B. Vann, manager of systems sales, and John W. Marshall, manager of project planning, Hoffman Laboratories Division, Hoffman Electronics Corp., Los Angeles, Calif.

G. A. Kious, manager military equipment engineering, and Andrew J. Vadasz, future systems engineer, General Electric's Communications Products Department, Syracuse.

James G. Hamelin, advertising and public relations manager, Gulton Industries, Inc., Metuchen, N. J.

Albert Green, quality control manager, Fairchild Controls Corp.'s West Coast Components Division, Los Angeles, Calif.

Joseph P. Gordon, general manager of Tube Operations, Allen B. Du Mont Laboratories, Inc., Clifton, N. J.

Howard E. Mers, manager, Beech Aircraft Corp.'s West Coast office, Los Angeles, Calif.

Richard B. Houghton, program director, Atlas, and John Thomas, director of operations, Acoustica Associates, Inc., Los Angeles, Calif.

Advances on the frontiers of electronics

At IBM, gifted scientists and engineers are searching out designs for new and highly advanced systems of computer logic. In this effort, recently formulated concepts of machine theory are explored and applied to developing such electronic innovations as . . . millimicrosecond digital computers . . . miniaturized computers . . . and unusually different automatic detection, diagnostic, and error-correction methods. This is only one of the many exciting areas for creative careers with IBM that await the talented scientific investigator.

A career with IBM. If you would enjoy solving difficult problems in a field of unlimited potential, investigate an IBM career. A recognized leader in the electronic systems field, IBM offers unusual opportunities for technical achievement and professional advancement. You will find stability, liberal company benefits, company-paid relocation expenses, advancement on merit—and a unique record of growth. Salaries are commensurate with your abilities and experience.

Assignments open in these development areas.

- Cryogenics
- Digital computer design and programming
- Guidance and detection systems analysis
- Low temperature physics
- Magnetic devices
- Optical systems for data presentation
- Solid-state physics

Qualifications B.S., M.S., or Ph.D. Degree in Electrical Engineering, Physics, Mathematics, or related disciplines. Industrial experience is desirable.

Write, outlining qualifications and experience, to:

Mr. D. H. Hammars, Dept. 524A
Military Products Division
IBM Corporation
Kingston, N. Y.

IBM®
MILITARY PRODUCTS

OPENATION ANALYSIS ANO RESEARCH
Analysis of new guided missile systems and commercial Air Traffic Control

Research of advanced small guided missile systems. Strong background in Math, Physics or other sciences.

AENOOYNAMICS ENGINEERS
Problems in Theoretical Aerodynamics, design, analysis, project studies and experimental

PRELIMINANY OESIGN ENCINEENS
Experience desirable in design fields of missiles, radars and advanced weapon systems

PHYSICS
Investigation in applied mechanics and solid state

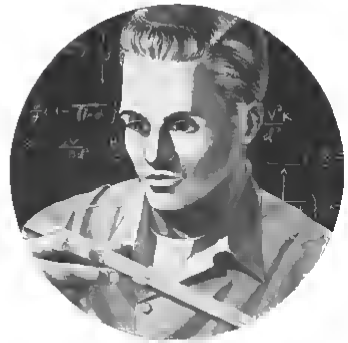
TNENMODYNAMICS ENOINEENS
For analytical and experimental work on missile propulsion systems, cooling and auxiliary power systems, heat transfer and gas dynamics problems

OESIGN ENGINEENS
Development, production design liaison and evaluation of electronic modules, hydraulic components, control systems, automatic test equipment and auxiliary power supplies for guidance and control systems

OYNAMICS ENCINEENS
To evaluate servo and guidance systems for missiles. Dynamics stability loads and aerolasticity

ELECTRONICS ENGINEENS
Research, development and design of microwave components, antennas, radomes and solid state investigations. Experience in automatic and digital testing techniques

ELECTRONIC WRITENS
For preparation of publications for electronic equipment.



thinking men

CONVAIR-POMONA

Home of the successful Terrier and Tartar Missiles

In SOUTHERN CALIFORNIA

Engineers discover maximum career stability and unlimited individual growth here at CONVAIR-POMONA, America's first fully integrated missile plant, engaged in research, development and production of missiles and highly advanced (still classified) weapons systems.

choose

CONVAIR-POMONA

1675 West Fifth, Pomona, California

CONVAIR IS A DIVISION OF GENERAL DYNAMICS CORPORATION

The excellent location of this modern air-conditioned plant offers unsurpassed living conditions. Suburban Pomona is only thirty minutes from Los Angeles and Hollywood and in close proximity to many recreational centers, the mountains, desert and ocean. Convair-Pomona is ideal for personal achievement and is within America's finest year-round living climate.

INTERVIEWS WILL BE HELO IR THESE ANO OTHER CITIES IN TNE REAN FUTURE:

Detroit • Royal Oak • New York • Chicago • Washington • St. Louis
Garden City • Baltimore • Indianapolis • Ft. Wayne • Minneapolis
Dayton • Cincinnati • Denver • Milwaukee • Palo Alto • Philadelphia
Boston • Salt Lake City • Cleveland

Forward resume at once, so arrangements for your personal interview can be made. Write to Mr. B. I. Dixon, Engineering Personnel Administrator, Dept. 12-A.

Relocation expenses paid to qualified applicants.

AERONAUTICAL ENGINEERS - -

Get in touch with AERONCA if you want . . .

- An opportunity with a Challenge
- Responsibility and Advancement
- A dynamic Growth Situation

Aeronca Manufacturing Corporation of Middletown, Ohio, has experienced recent dynamic growth in the high-strength to-weight ratio materials field. As one of the recognized leaders in this field our organization assures tremendous professional growth opportunities for the type of individual who has: (1) professional competence of the highest caliber, (2) outstanding initiative with personal drive and (3) recognized leadership ability. Address your inquiry to Mr. Wolpert, Personnel Dept., Aeronca Manufacturing Corporation, Middletown, Ohio.

AERONCA MANUFACTURING CORP.
Middletown, Ohio

CONTRACT ADMINISTRATOR

with

Honeywell Aeronautical Division
Minneapolis, Minn.

Challenging opportunity for individuals with management aspirations.

Position requires

- Experience in administration of contracts and purchase orders
- Aptitude for directing activities related to engineering, production, legal, accounting and marketing functions in order to fulfill contract obligations efficiently
- Ability to work effectively with all levels of managerial and non-managerial personnel

MBA and 2 to 3 years' experience in industry or government desired

All replies held in strictest confidence. Send resume to

BRUCE D WOOD — *Employment Manager*
T-14, 1433 Stevens Boulevard
Minneapolis 13, Minn

PROFESSIONAL PERSONNEL REQUISITION

AERODYNAMICIST

Design analysts of hypersonic configurations powered with air-breathing propulsion systems. Evaluate the utilization of advanced and unique engine cycles on various vehicles used for interception, long range missile, and booster missions.

Must be a specialist in supersonic aerodynamics with appropriate education and experience. Work provides broad technical responsibilities. Excellent individual, professional, and project potentials for recognition and advancement.

Contact: FLOYD E. NARGISS, Manager, Professional Personnel, 16551 Saticoy Street, Van Nuys, California

Advanced power and weapons support systems for air and space — **Marquardt**

VAN NUYS AND POMONA, CALIFORNIA • OGDEN UTAH

ENGINEERING PILOT

Must have engineering or science degree and recent B-52 pilot time. Engineering experience desirable. Include educational background and flight time breakdown for past 5 years in initial reply. Southeast location. Write to

P-9375, Aviation Week
Class Adv Div., P.O. Box 12, N.Y. 36, N.Y.

DISENCHANTED ENGINEERS

If your present employer has failed to utilize your full potential why not permit us to explore the parameters for your personal qualifications with the many dynamic young companies in aviation, electronics, missiles and rockets. We now have in excess of 4,000 openings in the $5,000 to $40,000 bracket all of which are fee paid. Why wait? Send resume in duplicate at once to—

FIDELITY PERSONNEL
1218 Chestnut Street, Philadelphia 7, Pa

—AIRLINE—
Maintenance and Engineering VP

For medium sized airline

Previous airline management experience necessary including budget and cost control. Salary open. All inquiries held confidential. Send detailed resume including age, education, experience and salary required to

AVIATION ACTIVITIES
148-15 Hillside Ave, Jamaica, New York

ADDRESS BOX NO. REPLIES TO: Box No.
Classified Adv. Div. of this publication.
Send to office nearest you.
NEW YORK 36: P. O. Box 12
CHICAGO 11: 520 N. Michigan Ave.
SAN FRANCISCO 4: 68 Post St.

POSITION VACANT

Certificated Airline Dispatchers for short distance amphibious IFR and VFR operation in Southeast Alaska. Communications experience operating two way radio and teletypes desirable. Air mail complete resume to Alaska Coastal Airlines, 2 Marine Way, Juneau, Alaska.

POSITIONS WANTED

Manufacturer's representative, successful sales background, pilot, college degree, young, desires an opportunity to grow with young company. Will relocate. PW-9845, Aviation Week.

Commercial Pilot-220 hours, single, age 29, speak Italian fluently, free to travel, desire flying position foreign or domestic. PW-9878, Aviation Week.

Coast Guard Pilot, 30, 6000 hrs TT, 750 helicopter Bell & Sikorsky S-55. Commercial helo single 16 yrs exp. Avail Feb 1959. PW-9869, Aviation Week.

Industrial photographer, still and motion pictures, several years in—plant and field test aircraft and missile including aerial and supervisory experience; graduate degree. Seeks relocation as present missile contract nearing completion. Complete resume on request. PW-9715, Aviation Week.

SELLING OPPORTUNITIES WANTED

Manufacturers Agent desires to represent equipment or parts manufacturer throughout the southeast. Qualified, experienced. RA-1686, Aviation Week.

To EMPLOYERS Who Advertise for MEN:

Frequently, when there are many applicants for a position, only the most promising letters are acknowledged. The other applicants never know whether their letters reached a prospective employer or not. These men often become discouraged, will not respond to future advertisements and even question their bona fide character.

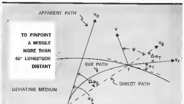
Every Advertisement Printed in the Searchlight Section Is Duly Authorized

You can help keep our readers interested and get better returns to your advertising in this section if you acknowledge each reply—in plain envelopes, if you wish.

Classified Advertising Division

McGRAW HILL PUBLISHING CO., INC.

"Put Yourself in his place"



Engineering Opportunities of a High Order in Creating Complex Identification & Tracking Equipments at General Electric's Missile Detection Systems Section

To locate a 15,000-mph missile despite complicating factors such as the varying refractive index of the troposphere and ionosphere, a high degree of systems sophistication is of paramount importance.

Growth opportunities commensurate with the creative and analytical demands implicit in such requirements are open now for experienced electronic engineers at G.E.'s Missile Detection Systems Section in these areas:

- Research & Development of New Detection Techniques
- Initiation & Development of Proposals
- Definition and Direction of Equipment Design
- Engineering Liaison with Military & Engineering-Manufacturing Sub-Contractors

Positions at Several Levels for Electronic Engineers

SYSTEMS DEVELOPMENT ENGINEERING
(At least 4 years' experience)

RADAR SYSTEMS
SYSTEMS ANALYSIS
DATA ANALYSIS
ELECTRONIC COUNTERMEASURES SYSTEMS

SYSTEMS EQUIPMENT ENGINEERING

ANTENNA DESIGN AND DEVELOPMENT
RF COMPONENTS DEVELOPMENT
UHF AND MICROWAVE RECEIVER DEVELOPMENT
DATA REDUCTION EQUIPMENT D & D
VIDEO DISPLAY DEVELOPMENT
COMPUTER APPLICATIONS

Salaries fully competitive, commensurate with experience.
Write in confidence to Mr. James P. Kinsella, Div. 58 W C

Missile Detection Systems Section
HEAVY MILITARY ELECTRONICS DEPT.

GENERAL ELECTRIC

Court Street, Syracuse, New York

Brilliant Ground-floor Opportunities for

SIX HIGH-LEVEL ENGINEERS

in a New Creative Missile Group

IN SUNNY SAN DIEGO

Six brilliant opportunities are open for creative engineers in Solar's new missile group The projects involved are exceptionally exciting and challenging but cannot be publicly announced at this time. The right six men joining now will get in on the ground floor and gain key creative positions in their fields of interest.

AREAS OF EXPERIENCE SOUGHT

Flight mechanics, analysis of missile trajectories missile dynamics, stability and control, aeroballistics airborne fire control computers, data links statistical error and control response error analysis servo mechanisms, precision airborne hydraulic servos

SOLAR SPECIFICS

Solar is a medium size company (2500 people in San Diego) with a successful history since 1927 It is big enough to offer the most advanced personnel policies, yet small enough so you don't get lost in the crowd Salary and performance reviewed semi-annually Solar is making many significant contributions to space age technology and the special professional status of engineers is fully appreciated and recognized A new 60,000 sq ft. engineering building, necessitated by expanding research and development, will be completed in 1959

IDEAL LOCATION

Solar is located in sunny San Diego with the finest year-around climate in the U S Recreational, cultural and educational facilities are superb The new advanced science branch of the University of California offers exceptional opportunities for further study Outdoor living and sport can be enjoyed all year long You and your family will really "live" in San Diego!

SEND RESUME

Please send resume of your qualifications at the earliest opportunity to Louis Klein, Dept E-335, Solar Aircraft Company, 2200 Pacific Highway, San Diego 12, Calif

SOLAR AIRCRAFT COMPANY SAN DIEGO DES MOINES

FOR ADDITIONAL INFORMATION

About Classified Advertising,

Contact

The McGraw-Hill Office Nearest You.

ATLANTA, 3— 1301 Rhodes Haverty Bldg JAckson 3-6951
R H POWELL

BOSTON, 16—350 Park Square HUbbard 2-7160
D J CASSIDY

CHICAGO, 11—520 No Michigan Ave MOhawk 4-5800
W J HIGGENS D C JACKMAN

CLEVELAND, 13— 55 Public Square SUperior 1-7000
W B SULLIVAN

DALLAS, 2—1712 Commerce St, Vaughan Bldg Riverside 7-5117
GORDON JONES F E HOLLAND

DETROIT, 26—856 Penobscot Bldg WOodward 2-1793
D M WATSON

LOS ANGELES, 17—1125 W 6 St HUntley 2-5450
R L YOCOM

NEW YORK, 36—500 Fifth Ave OXford 5-5959
D T COSTER R P LAWLESS

PHILADELPHIA, 3— 17th & Sansom St RIttenhouse 6-0670
H W SOZARTH T W McCLURE

ST LOUIS, 8—3615 Olive St, JEfferson 5 4867

SAN FRANCISCO, 4—68 Post St DOuglas 2-4600
W C WOOLSTON

NEED ENGINEERS?

An employment advertisement in the EMPLOYMENT OPPORTUNITIES SECTION will help you find the engineers you need It's an inexpensive, time-saving method of contacting competent personnel for every engineering job in the Aviation industry The all paid circulation of AVIATION WEEK offers you an opportunity to choose the best qualified men available

For rates and information write:

Classified Advertising Division

AVIATION WEEK
P.O. Box 12
New York 36, N. Y.

PROFESSIONAL PERSONNEL REQUISITION

Combustion Engineer

To join a group of engineers and scientists in exploring the release of energy from various materials possessing unusual energy potential These materials are known to hold great promise as fuels for hypersonic propulsion systems, but additional research and evaluation is necessary to make them fully productive

Work requires extensive experience in combustion analysis and combustor designs Position is in ASTRO, Marquardt's Air Space Travel Research Organization. You will be joining a group which is making important advances in many areas of advanced power systems.

For Information Contact
Floyd E Hargiss Manager Professional Personnel, 16551 Saticoy Street, Van Nuys, California

Advanced power and weapons support systems for air and space **Marquardt**
VAN NUYS AND POMONA, CALIFORNIA OGDEN UTAH AIRCRAFT CO.

CLASSIFIED **SEARCHLIGHT SECTION** ADVERTISING

BUSINESS OPPORTUNITIES EQUIPMENT - USED or RESALE

FOR SALE

GRUMMAN MALLARD

Executive Aircraft

Always received best in maintenance. Interior recently refinished. 3500 hours total A.F. time Right engine 3 S.O.H. Left engine 850 hrs. S O H. Good radio. Two spare engines. One spare propeller plus numerous other spares

Deal directly with owner Write

FS-9211, Aviation Week
Class. Adv Div P O Box 12 N Y 36 N Y

If there is anything you want
that other readers can supply
OR . . . something you don't want—
that other readers can use—
Advertise it in the
SEARCHLIGHT SECTION

AIRCRAFT & PARTS

Beechcraft D18S 632 total hrs. low engines
1945 Nana located in N Y area $5500
Bonanza 320 Aero Commander $7500
Disassembled 1956 Cessna Skylane $9000
2—1830-94 P&W engines $9000 ea
Bendix and Leland Inverters (radar) $150 ea.
43E60 7&8 Prop domes & hub reversible $1000 ea.

A J O'KEEFE
17 First St Hackensack, N. J. Colfax 2 1641

ADDRESS BOX NO. REPLIES TO Box No
Classified Adv Div of this publication
Send to office nearest you
NEW YORK 36 P O BOX 12
CHICAGO 11 520 N Michigan Ave
SAN FRANCISCO 4 68 Post St

BUSINESS OPPORTUNITIES

Export—Old established, well organized New York exporter would like to take over export management for substantial lines BO 5d59 Aviation Week

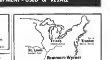
Experienced aeronautical engineers New York metropolitan area, wanted on Services for Shares basis for development of five place twin-jet executive aircraft BO-8702, Aviation Week

FOR LEASE

Cessna 36R Late Model 44R hours Excellent Condition Lease Purchase Arrangements Write P O Box 312 Lancaster California

MISCELLANEOUS

Helicopter Blue Prints and Technical Construction data Send $1.00 for 3 view drawing Pioneer Helicopter Co Hallandale, Florida



Immediate Delivery

We stock, overhaul and install

PRATT & WHITNEY **R1830** –75 –92 –94

WRIGHT **R1820** –202, –5 –72

R985 R1340 R2000

and our most popular DC3 engine
R1830 - SUPER - 92

ENGINE WORKS
INC

Lambert Field Inc. St Louis Mo

ADVERTISERS IN THIS ISSUE

AVIATION WEEK, JANUARY 19, 1959

LETTERS

Airline Strike

The strike of pilots against American Airlines, at the onset of the holiday rush, amounts to little more than public blackmail. To the tens of thousands of stranded travelers, it appears that American's pilots have forgotten the meaning of "Peace on Earth Good Will Towards Men"

The damage to labor's reputation by such a strike as this will be beyond calculation. I, for one, have been turned from labor's friend to foe by this despicable act.

MALCOLM H. DUBIN
Prospect, Ky.

'Strike' Season

"Never before has so much been owed to so few," is the thought which Mr. Edwards believes could apply to American (especially airlines) pilots (AW Dec. 15, p. 122).

A few issues ago AVIATION WEEK reported the president of the Air Transport Assn. as having expressed the general idea that so much would be earned by so few pilots. His exact words are not at hand because I think they were in a copy of AVIATION WEEK that my boy cut up for the fine airplane and rocket pictures.

Possibly the above diversified views are why this neutral pilot will use ground transportation for family travel during the holiday (strike) season.

ROBERT E. TRIMBLE
Washington, D. C.

Goose Cancellation

Recent cancellation of the Goose development program by the Air Force involves a situation which should be brought to the attention of Congress and its taxpaying constituents.

War gaming studies conducted for the Air Force by independent research agencies have proven that the "defense-per-dollar" capability of a B-47 or B-52 bomber force is greatly increased by the employment of the Goose decoy weapon system. This can be shown in terms of total cost per megaton of bombs delivered on target. No other equivalent system is in development.

If these studies are valid (and it is assumed that they are, since our entire defense posture is based on similar studies), then we should save money by implementing the Goose weapon system and cutting back slightly on B-52 procurement, thereby buying better defense for less money.

If these studies are not valid (as is implied by the Goose cancellation), then we should save money by eliminating a large portion of similar studies which are costing millions of dollars per year.

Incidentally, Fairchild has achieved a remarkable record in the Goose development program, and Air Force has indicated that cancellation was due only to lack of funds.

How about it, Congress? Should the Goose be reinstated, or should we call a halt to spending for theoretical operational studies whose results are disregarded?

ENGINEER
Hagerstown, Md.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

British Contribution

It was a pleasure to read your editorial comment in the Oct. 20 issue (p. 21) of AVIATION WEEK concerning the British contribution to the current jet transport picture. It has been my opinion that they have done a fine job in a distinctly pioneering effort, even considering their government's support. This expression of your viewpoint reaffirms my feeling that we get a fair look at both sides of today's aviation problems in your publication.

J. BYRNE HULL
Ampex Corp.
Redwood City, Calif.

Rule Enforcement

In a recent letter to AVIATION WEEK written by me concerning lightplane rule enforcement (AW Sept. 1, p. 90), I asked for the enforcement of regulations, not more rules as so wrongfully misinterpreted by some and mistitled by AVIATION WEEK.

What I perhaps failed to make clear is that what is needed is enforcement of rules on lightplane traffic similar to the enforcement at Naval or Air Force Flight Operations Departments or a central control where each pilot will file a flight plan, exhibit proper credentials and establish he has checked the weather en route and signs same thus taking the responsibility for complying. If, in the opinion of the controlling authority, the pilot cannot safely proceed he will not take off, thus preventing the accident before it has occurred or closing the door in front of the horse, as the case may be. On the flight plan, I suggest such things as total flight time, recent instrument, night, and cross country time be stated.

I'm sure Beech Aircraft Corp. will back me up considering the number of cases against them when "pilots" have exceeded the G tolerances on the Bonanza in recovery from unusual attitudes induced by pilots on instruments. Luckily, the test case was dismissed in New Jersey against them. If we look farther we'll find two-thirds of all accidents are pilot caused and the rest maintenance error, or total human error closer to 99% which is the only similarity to the automobile and in itself another study.

Maximum control of aircraft or missiles, stated in order, are the missile launch, an aircraft carrier land and launch, a CAA radar approach control, an Air Force or Naval Air Station aircraft control, a civilian tower, and a poor last is lightplane traffic control which can only improve if the right attitude is taken or how many small aircraft clutter a GCA pattern or low station. These patterns could be policed by such aircraft as surplus T-28Bs with police powers to at least invoke the age old 'cop at the elbow' test, or would you be breaking every law in the book if there were fear of apprehension or an air police were near.

In World War II in Korea, in training the ultimate air safety and effectiveness of purpose or rule enforcement known simply as air discipline has done more to win wars than any other single principle which can and should be applied to light aircraft pilots.

No one wants the ultimate or complete control of light aircraft but any improvement would be a welcome step if you've been in the air lately.

H. B. DAVIS
Burbank, Calif.

P. S. To help qualify for the above opinions, I have averaged one hour a day in fighter type aircraft for the last 16 years.

(Reader Davis' Sept. 1 letter was titled "Lightplane Rules," which was meant to indicate the general subject of the letter, not to interpret it.—Ed.)

T53 Ingestion

We at Lycoming were very pleased with the excellent article on the Bell H-40 in the Dec. 8 issue of AVIATION WEEK (p. 76). In a discussion of the powerplant for this new Army utility helicopter the Lycoming T53 gas turbine, I would like to call your attention to one misstatement with reference to the desert trials of the copter and engine.

You stated that, "During desert trials, the engine ingested 65 lb. of sand continuously over a 25-hr. period, with loss of only 10% power." The fact is that your sentence prior to this one is correct, and the "Engine also was run through severe 50-hr. desert test in Yuma, Ariz." Recalibration showed a loss of only 1% in fuel consumption at full rated power and 2% at 75% power. The 10% loss was experienced in special test cell runs at Lycoming during which the engine ingested 65 lb. of sand continuously over a 25-hr. period.

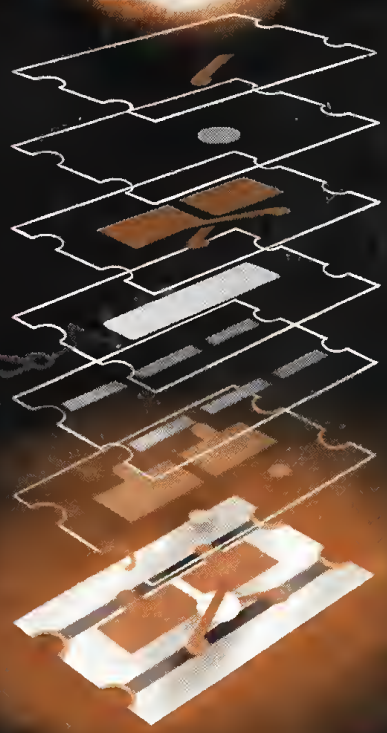
PAUL A. DEEGAN
Public Relations & Advertising
Lycoming Division
Avco Manufacturing Corp.
Stratford, Conn.

Jet Penalties

May I through your publication congratulate Lt. Col. John C. Grando on his excellent letter in your Dec. 1 issue (p. 106). For many years now, we in British Overseas Airways Corp. have been unrestrainedly vocal in asserting on every possible occasion that ATC procedures should be designed to suit the requirements of jet aircraft. Penalizing these aircraft by insisting on compliance with obsolescent ATC practices is utterly wrong. Right now in this country we are pressing a sympathetic Ministry to provide special jet climb-out paths in the London area and in spite of many difficulties I have no doubt they will be provided in the near future.

E. W. PIKE
Deputy Flight Services Manager
British Overseas Airways Corp.
London Airport, England

VACUUM LAMINATED MICROCIRCUITRY



Setting the pace in the field of evaporated film technology, Servomechanisms, Inc.'s Research Laboratory is developing a whole new concept of component and subsystem design under sponsorship by the U.S. Air Force, the Army Signal Corps and the Office of Naval Research.

As a result of new materials research by SMI, thin-film Magnetic, Conducting and Dielectric elements which exhibit highly controllable electrical and physical characteristics are being produced now by high vacuum thermal evaporation techniques utilizing electron bombardment.

These micro-miniaturized elements improve system and component reliability while providing a significant reduction in size and weight. This, plus the ability to withstand extreme environmental exposure, makes them invaluable in the design of digital computers, electronic communications equipment, missile controls and digital transducers for space vehicles, satellites and other advanced systems.

New system analysis and design has progressed in step with these advances in materials and techniques. SMI's Research Laboratory would welcome the opportunity to discuss and propose solutions to your microcircuitry and advanced systems problems.

SERVOMECHANISMS SMI INC.

GENERAL OFFICES
12500 Aviation Boulevard, Hawthorne, California

SUBSYSTEMS DIVISION
Hawthorne, California

MECHATROL DIVISION
Westbury, L.I., New York

SPECIAL PRODUCTS DIVISION
Hawthorne, California

RESEARCH LABORATORY
Goleta, California

The products of SMI are available in Canada and throughout the world through Servomechanisms (Canada) Limited, Toronto 15, Ontario